Delaware Mosquito Control Section

Pesticide Discharge Management Plan

2012

DNREC Pesticide General Permit
(Clean Water Act NPDES Permit for aquatic pesticide use)

Delaware Mosquito Control Section
Delaware Division of Fish and Wildlife
Delaware Dept. of Natural Resources and Environmental Control
89 Kings Highway
Dover, DE. 19901

Office phone: 302-739-9917
Fax number: 302-739-6157
Email: William.Meredith@state.de.us

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I. <u>Pesticide Discharge Management Team</u>

All persons may be contacted through the Delaware Mosquito Control Section, per the address and contact information on the title (cover) page.

1. Person(s) responsible for managing pests in relation to the pest management.

   a. William H. Meredith – Environmental Program Administrator
   b. Thomas Moran – Regional Manager, Glasgow Office (northern/upstate region)
   c. Kenneth Conaway – Regional Manager, Milford Office (southern/downstate region)

2. Person(s) responsible for developing, revising or storing the PDMP.

   d. William H. Meredith – Environmental Program Administrator
   e. Thomas Moran – Regional Manager, Glasgow Office (northern/upstate region)
   f. Kenneth Conaway – Regional Manager, Milford Office (southern/downstate region)

3. Person(s) responsible for developing, revising, and implementing corrective actions and other effluent limitations.

   g. William H. Meredith – Environmental Program Administrator
   h. Thomas Moran – Regional Manager, Glasgow Office (northern/upstate region)
   i. Kenneth Conaway – Regional Manager, Milford Office (southern/downstate region)

4. Person(s) responsible for pesticide applications (mix, load, apply), including their Delaware Dept. of Agriculture (DDA) Certified Applicator License Numbers.

   Delaware Mosquito Control Section (MCS) staff:

   a. William H. Meredith – Environmental Program Administrator (83-261)
   b. Thomas Moran – Regional Manager (91-138)
   c. Kenneth Conaway – Regional Manager (01-163)
   d. Robert Meadows – Environmental Scientist (00-996)
   e. Kimberly A. Brinson – Environmental Scientist (07-726)
   f. Paul M. Zarebicki – Environmental Scientist (01-320)
   g. James M. Joachimowski – Environmental Scientist (05-054)
   h. Thomas Burke – Conservation Technician Manager (04-840)
   i. Arthur A. Loveless – Conservation Technician (90-309)
   j. Darryl L. Duffie – Conservation Technician (92-479)

k. Joseph Shockley – Conservation Technician (08-846)
l. Mark Cashdan – Master Mechanic (99-761)
m. William M. Reid – Biological Aid/Env. Control Technician equivalent (10-227)
n. David Moore – Biological Aid/Env. Control Technician equivalent (02-474)
o. Ashley Warnick – Biological Aid/Env. Control Technician equivalent (12-553)
p. Various summer seasonal employees of the MCS having some pesticide use training work under direction, supervision or auspices of MCS staff who are certified applicators

Other DNREC Division of Fish and Wildlife staff:

q. Various Wildlife Section or Fisheries Section staff who are DDA Certified Applicators, and who occasionally perform ground applications of mosquitocides (e.g. as "relief foggers") upon request by the Mosquito Control Section, and who are then also working under direction, supervision or auspices of MCS staff who are also DDA Certified Applicators, including in part:

    1. Timothy Bennett (84-284)
    2. Aaron Deiter (08-844)
    3. Wade Dunning (10-274)
    4. Rob Ebert (10-271)
    5. Garry Glanden (10-275)
    6. Derek Harvey (10-273)
    7. Walter Hearn (08-845)
    8. Carl Meadwell (05-050)
    9. Jerry Mitchell (01-161)
    10. Nathan Rust (10-278)
    11. Jason Seeney (10-301)
    12. Jordan Zimmerman (10-277)
    13. Mark Zimmermann (88-227)

Contractual Aerial Applicators – at present, Allen Chorman & Son, Inc. or Chorman Spraying, LLC (30475 E. Mill Run, Milton, DE, 19968), for fixed-wing aircraft or helicopter spraying:

State of Delaware Pesticide Business License Numbers for Allen Chorman & Son, Inc., for Mosquito, Aquatic, Forest, and Ag Plant:

Allen Chorman & Son Inc. - #439
Chorman Spraying LLC - #1467

r. Allen Chorman, Pilot/Owner-Operator (78-178)
s. Jeffery Chorman, Pilot/Owner-Operator (02-454)

t. Employees of Allen Chorman & Sons, Inc. or Chorman Spraying, LLC, who either as pilots or ground personnel are certified to handle or apply pesticides, or who work under direction or supervision of the contractor's certified applicators, including in part:
   Mark Greenly (93-711)
   James (Blair) Thompson (09-136)

u. Sub-contractors of Allen Chorman & Son, Inc. or Chorman Spraying, LLC, at present including Helicopter Applicators, Inc. (Gettysburg, PA), pertaining to sub-contractor employees who either as pilots or ground personnel are certified to handle or apply pesticides, or who work under direction or supervision of the contractor's or sub-contractor's certified applicators, including in part for Helicopter Applicators, Inc.:
   Glen Martin (78-423)
   Gerald Racey (03-667)
   Brian Redding (00-005)
   William Farwell (05-222)
   John McHenry III (08-797)

II. Problem Identification

A. Pest Problem Description

As natural resource management professionals charged with mosquito control responsibilities, the Delaware Mosquito Control Section is asked to perform some complex undertakings. We are tasked to somehow reach into the environment to eliminate or nullify a suite of quality-of-life, public health, and economic problems of serious concern to many Delawareans. These problems are generated by organisms that in their immature stages are found throughout the state in almost every type of aquatic habitat imaginable (with exception of the middle of fast-running streams), and which if uncontrolled are then airborne as adults and capable of widespread dispersal and much pestilence. The most practicable modern control tools that we have at our disposal are insecticides that we must judiciously spray over or within wetlands or other mosquito production habitats to control immature stages, but which we also sometimes have to directly apply over or within where people live, work or recreate in upland habitats, or over wetlands or other types of water, to control adult mosquitoes. We also employ various wetland management techniques for larval control that must be carefully installed or implemented in very sensitive, very valuable environments, and additionally rely heavily upon public education and outreach to help us meet our goals.

Overall Problems

Approximately 57 species of mosquitoes are found in Delaware, and about 19 species can be aggressive biters of humans, as well as other mammals and birds too.

These 19 species can be common or abundant enough to occasionally or frequently cause problems for:

a) Delawareans' quality-of-life (i.e. nuisance/annoyance/pestilence issues);
b) Public health (i.e. disease issues), with primary concerns for West Nile virus (WNV) and eastern equine encephalitis (EEE), both which can affect not only humans but horses, and which can lead to severe long-term health consequences or even death in some cases; also concerns about canine health relative to dog heartworm.
c) Local way-of-life (i.e. socio-economic issues affecting tourism, outdoor recreation, animal husbandry, property values).

The remaining approximate 38 species that do not feed on humans get their blood meals from a wide variety of other hosts, including their feeding upon amphibians, reptiles, birds or other mammals, although for any given mosquito species the preferred blood meal hosts can sometimes be quite specific. However, even some of these non-people biters can still indirectly become problematic for humans, either by their feeding upon our domesticated animals, or by their circulating or maintaining virus pools or reservoirs in other host animals (e.g. wild birds), for diseases that can eventually be transmitted to people by one of the 19 human-biters ("bridge vectors").

Pestilence, quality-of-life, economic problems

At one time before the advent of modern mosquito control practices in Delaware, dating back essentially to the late 1950s and before, many developed areas of the First State (e.g. downtown Dover!) would more than occasionally experience severe mosquito infestations having landing rate counts of biting adult mosquitoes from 20-50 per minute up to 100 bites per minute, which through nuisance or annoyance alone greatly diminishes an area's quality-of-life. A landing rate count of only 1-2 mosquitoes per minute in a backyard on some balmy summer evening would translate within a half-hour into 30-60 bites affecting exposed parts of a person's body, clearly not a desirable situation. Imagine how long one would stay outside in a setting of 20-50 bites per minute, with truly ghastly counts of 100 bites per minute having been documented! And as more-and-more people move into Delaware, and as they increasingly seem to all want to live in areas near coastal wetlands or wet woodlands, demands for our control services (and upon our program's limited resources) only continue to escalate.

In addition to personal discomfort from such infestation levels, uncontrolled mosquito populations can also have significant adverse impacts to local economies based upon tourism, outdoor recreation, or animal husbandry, along with undesirable effects on a neighborhood's property values. As such, our delivery of mosquito control helps to maintain a good quality-of-life and robust economy throughout many areas of Delaware – without our continuous, behind-the-scene control efforts, a large portion of modern Delaware would not be very livable from early April through early November. Many visitors coming to our coastal resort areas from Baltimore, Washington, northern Virginia, the New York City area, northern New Jersey, Philadelphia, southeastern

Pennsylvania, Wilmington, Newark or other urban regions do not realize how naturally "buggy" a place they've chosen to visit. It's somewhat bemusing when some of these good folks first realize what we have to do to make their visits a relatively pest-free (and disease-free) experience – incongruously, they'll sometimes ask: "What do you need mosquito control for? The number of mosquitoes flying around here aren't that bad."

Mosquito-borne Diseases and Related Public Health Problems

Another major reason for controlling mosquitoes is their well-known potential for carrying and transmitting pathogens that can cause diseases, not only just to humans, but also to our domesticated animals such horses or dogs. In Delaware today, we are concerned with encephalitis viruses such as eastern equine encephalitis (EEE), an alphavirus, which when either humans or horses contract EEE can often be fatal, with special concern for children and the elderly. Those who recover from EEE are often left with lifelong debilitating symptoms – there is an EEE vaccine for horses, but not for humans. EEE virus has been known to occur in Delaware for many decades, where it is enzootic/endemic and a permanent part of our environmental landscape. Fortunately, the occurrence of EEE is relatively rare, and the Mosquito Control Section works hard to keep it this way.

West Nile virus (WNV), a flavivirus, is a recently-introduced Old World encephalitis virus first coming into the country in 1999 in the New York City area, carried by wild birds and mosquitoes that has now spread from coast-to-coast. This virus first appeared in Delaware in 2002, and is now well established throughout the state (i.e. it has also become enzootic/endemic). West Nile virus is not as virulent as EEE, but nonetheless contracting WNV is still quite a medical concern for the elderly or people having impaired immune systems, and whereby some WNV victims who may have had a near-death experience but then recover might still have to endure long-term, debilitating neurological sequelae. An effective WNV vaccine has now been developed for horses, but if a WNV vaccine is ever developed for humans, it's probably still many years away.

The occurrence of EEE and WNV in nature involves complex transmission cycles of several mosquito species and wild birds (songbirds play a very prominent role here), with a branching off to humans and horses in these cycles as "dead end" hosts for encephalitis viruses.

Other encephalitides of much more minor concern in Delaware include St. Louis Encephalitis (SLE), another flavivirus, which at times has had epidemic outbreaks in the central U.S. and Florida; as well as the potential for LaCrosse Encephalitis (LAC), a bunyavirus, which is usually associated with the mid-West, but in recent years has become more problematic in nearby states such as West Virginia or North Carolina.

Mosquito bites per se, even without pathogen transmissions, are also a human health problem, as mothers can readily attest when their children are festooned with numerous bites and can't fall asleep all night long. Excessive numbers of mosquito bites per se, sans any pathogen transmission, can cause allergenic problems at bite sites (or even systemically) for extremely sensitive individuals, can lead to secondary infections from aggressively scratching bites sites (children are most prone to doing this), and can cause psychogenic problems from mental anguish/torment. These types of human health problems from excessive number of mosquito bites even without any pathogen transmissions are recognized as significant health concerns by many pediatricians, by the federal Department of Health and Human Services' Centers for Disease Control (CDC), and under the federal Food Quality and Protection Act (FQPA), whereby for the latter pest-induced discomfort is noted as a human health problem. And you certainly don't have to ask the public if their suffering too many mosquito bites, even without their catching some type of mosquito-borne disease, is a human health problem!

Many Delawareans are probably not aware that so-called "tropical" diseases, such as yellow fever (a flavivirus) or malaria (a protozoan parasite, *Plasmodium* spp.), were at one time quite common in the southeastern United States, including areas as far north as Delaware and even into New England. A yellow fever outbreak in Philadelphia in 1793 killed 10% of the city's residents and sickened another 20%. Malaria was a serious problem for Civil War soldiers throughout the southeast, including Confederate prisoners confined to Fort Delaware on Pea Patch Island, and as recently as only a few years ago isolated but locally-transmitted cases of malaria surfaced in New Jersey and Maryland. Many a colonial estate or antebellum plantation owner along the southeastern seaboard, including Delaware and other areas of the mid-Atlantic, knew that come summer it was time to seek refuge further inland or up in the mountains for themselves and their privileged families, to thereby avoid the "swamp ague" or "bad air" (malaria is Italian for bad air) that often somehow caused great sickness for those less fortunate who had to remain behind.

Dengue ("breakbone") fever, a flavivirus, is currently a mosquito-borne problem throughout the Caribbean and Mexico, with recent occurrences in southern Texas and the Florida Keys, plus potential for this disease in other Gulf Coast states too. A serious outbreak of dengue recently occurred in Hawaii -- the hemorrhagic form of dengue can often be fatal. The primary mosquito vector for dengue, *Aedes aegypti*, is limited by cold weather for its distribution along the eastern seaboard, not to be found northward of the Carolinas, but with global warming its geographic range might extend further north over time, and as such the occurrence of dengue fever might also creep northward. The Asian tiger mosquito, *Aedes albopictus*, is now a very abundant species in urban areas as far north as New Jersey and has become a major problem within Delaware, and in its native southeast Asia is a major vector for dengue fever, so there's additional concern here for what the future of dengue might hold in store.

It is only through continued vigilance and proactive implementation of modern mosquito control practices within the United States, combined with good disease screening and follow-up medical care, that these "tropical" diseases are no longer major concerns in the lives of most modern Americans, including Delawareans. But an example of a mosquito-borne disease that might prove to be the next newly emerging infectious disease in the United States is chikungunya, an alphavirus causing debilitating febrile illness and incapacitating joint pain, originating from tropical Africa that in recent years has caused major disease outbreaks in India; and most recently in fairly alarming manner, chikungunya had spread to temperate climes in Italy, in concert with how both people and organisms can now rapidly travel around the globe. Another mosquito-borne disease that epidemiologists are also concerned about in regard to its possible future spread is Rift Valley Fever. Modern-day mosquito control practices must be vigilantly and aggressively employed if we are to avoid or lessen the global spread of these mosquito-borne ills.

Another mosquito-caused disease problem in Delaware is canine heartworm, a mosquito-borne pathogen often fatal to dogs, so dog owners are urged to put their dogs on preventive medication to avoid this problem.

Delaware's 19 problematic mosquito species

To provide a feel for what the Mosquito Control Section faces in dealing with this range of species, Delaware's 19 problematic mosquitoes are listed below, along with some annotated comments about their breeding habitats, occurrences, behaviors and the problems they cause. Also provided is an accounting of 3 other mosquito species that are not problematic to humans in terms of their direct biting behaviors, but which can indirectly still cause us trouble by cycling disease viruses in other host animals; along with the description of another human-biter and disease vector of historic note in Delaware, and possible future concern again.

1) *Ochlerotatus (Aedes) sollicitans* – Common Saltmarsh Mosquito

   #1 pest breeding in temporary waters ("potholes") of coastal wetlands, erupts after lunar tidal floodings or rainfall events, Apr-Oct, bites day/night, long-distance flyer; as with most *Ochlerotatus* (*Aedes*) species, overwinters in an egg stage, and can produce several generations during the warmer seasons, depending upon rainfall or flooding patterns; lays its eggs singly on moist muds, hatching after inundation; primary EEE vector, also found WNV-positive in the field.

2) *Ochlerotatus (Aedes) cantator* – Brown Saltmarsh Mosquito

   Similar to *Oc. sollicitans*, but sometimes appearing as early as April, and not as abundant in late summer/fall, nor as active in day; EEE vector, also found WNV-positive in the field.

3) *Ochlerotatus (Aedes) taeniorhyncus* – Black Saltmarsh Mosquito

   Also similar to *Oc. sollicitans,* but not as active in day, more of a problem downstate (the major problem saltmarsh mosquito in many areas of southeastern U.S.); found WNV-positive in the field.

4) *Ochlerotatus (Aedes) canadensis* – Woodland Pool Mosquito

#1 spring problem in temporary woodland pools, long-lived and usually associated with only one major spring brood, but sometimes a late summer brood too, relatively limited flight range; found WNV-positive in the field.

5) *Ochlerotatus (Aedes) grossbecki* – "Grossbecki"

Early-season breeder in woodland pools and swamps, teams with *Oc. canadensis* in creating severe springtime nuisance problems near wet woodlands.

6) *Ochlerotatus (Aedes) triseriatus* – Eastern Treehole Mosquito

Container-breeder, often in natural water-holding structures such as treeholes, laying its eggs at the waterline or slightly above; Lacrosse Encephalitis vector in mid-West, found WNV-positive in the field.

7) *Aedes vexans* – Floodwater Mosquito or "Vexans"

Temporary waters of inland freshwater wetlands and wet woodlots, #1 summer woodland-pool pest, long-distance flyer, evening/night biter; EEE vector, found WNV-positive in the field.

8) *Aedes albopictus* – Asian Tiger Mosquito or "Albos"

Arrived in late 1980's, container-breeder, now major urban problem, loves tire piles, aggressive daytime biter (especially in lower extremities), limited flight range; found WNV-positive in the field, and highly WNV-competent in the lab (in Far East, also dengue fever vector).

9) *Ochlerotatus (Aedes) japonicus* – Japanese or Rockpool Mosquito

First found in Delaware in 2000, container-breeder and in other isolated standing waters; not too numerous yet, but similar to the introduced *Ae. albopictus* could become urban/domestic nuisance problem; found WNV-positive in the field and also highly WNV-competent in the lab.

10) *Culex pipiens* – Common House Mosquito (northern subspecies = *pipiens* and southern subspecies = *quinquefasciatus*, with overlap of ranges in Delaware).

Major problem in domestic environs, primarily takes avian blood meals but will also readily bite humans, container-breeder around houses, also likes sewer catch-basins and stormwater or wastewater lagoons, limited flight range, night biter; like most *Culex* species, lays its eggs in batches or clusters (“rafts”) in still or quiet water habitats; can continuously breed throughout the summer, producing several generations, and overwinters as a resting adult; found WNV-positive in the field, and the suspected primary WNV vector (and for St. Louis Encephalitis elsewhere too).

11) *<u>Culex salinarius</u>* -- Unbanded Saltmarsh Mosquito or “Little Sal”

Breeds in standing waters of coastal wetlands both salt and fresh, night biter, locally very abundant, seems to prefer mammalian blood meals more than other *Culex*; found WNV-positive in the field, and a probable WNV vector.

12) *<u>Coquilletidia (Mansonia) perturbans</u>* – Cattail or Irritating Mosquito

Freshwater marshes with thick vegetation, one generation per year emerging in late spring/early summer, characteristic of cattail marshes where overwintering larvae live in mud bottoms and get their oxygen supply from air channels in plant roots, long-distance flyers, aggressive evening and nighttime biters, sometimes in daytime too; EEE vector, found WNV-positive in the field.

13) *<u>Anopheles quadrimaculatus</u>* – Common Malaria Mosquito or “Quads”

Permanent waters of freshwater wetlands, night biter, will enter houses, limited flight range; like most *Anopheles* species, overwinters as resting adult; notorious historic vector for malaria in southeastern U.S. (including latitudes as far north as Delaware up to Staten Island), and still capable of transmitting malaria within local populations if infectious humans carrying malaria are present (as sometimes still happens in mid-Atlantic states with immigrant arrivals or people returning from overseas trips); found WNV-positive in the field.

14) *<u>Anopheles punctipennis</u>* – Mottled-Wing Mosquito or “Punkies”

Similar to *An. quadrimaculatus*, and although an aggressive outdoor biter, not as likely to enter houses, nor to be a malaria vector; found WNV-positive in the field.

15) *<u>Anopheles bradleyi</u>* – “Brads”

Breeds in permanent waters of coastal wetlands both salt and fresh, night biter, moderate flight range; *An crucians* is its more inland ecological equivalent; *An. bradleyi/crucians* complex found WNV-positive in the field.

16) *<u>Anopheles walkeri</u>* -- "Walkeri"

Similar in many ways to *An. quadrimaculatus*, will readily bite humans, and can transmit malaria in the lab, but its role in the field for malaria transmission is undetermined; unlike many other *Anopheles* that overwinter as resting adults, *An. walkeri* toward the northern edge of its range passes the winter in an egg stage.

17) *<u>Psorophora columbiae (confinnis)</u>* -- Dark Ricefield or Glades Mosquito

Temporary waters of freshwater wetlands or irrigated systems, long-distance flyers, aggressive day/night biter; like many *Psorophora* species, has egg-laying and overwintering habits similar to *Ochlerotatus* (*Aedes*) species; found WNV-positive in the field.

18) *<u>Psorophora ciliata</u>* – "Gallinipper"

Similar in breeding habitat to *Ps. columbiae* and *Ae. vexans,* a large-sized mosquito often noticeably alarming to public, aggressive day/night biter; found WNV-positive in the field. *Ps. howardii* is another large species very similar to *Ps. ciliata* in larval and adult behavior, but much rarer.

19) *<u>Psorophora ferox</u>* – White-footed Woods or Big Woods Mosquito

Temporary waters of woody swamplands, aggressive day/night biter, especially near woodland margins; found WNV-positive in the field.

Other mosquito species affecting humans in Delaware:

1) *<u>Culiseta melanura</u>* -- Cedar Swamp or Black-tailed Mosquito

Not a problem biter for humans; it's a species of wet woodlands, with larvae often found in stump holes of maple-gum swamps; adults feed in the forest's upper canopy, and as such are a primary EEE vector among birds; also found WNV-positive in the field. *Cu. inornata* is another closely related species.

2) *<u>Culex restuans</u>* – White-dotted Mosquito

Similar in appearance and breeding habitats to *Cx. pipiens,* but not as likely to bite humans, in its much more preferring avian blood meals; found WNV-positive in the field, and as such possibly an important WNV vector among birds.

3) *Culex territans* **–** “Territans”

Another abundant *Culex* species that doesn’t readily bite man, but similar to *Cx. restuans* it might be an important WNV vector among birds; but not yet found WNV-positive in the field.

4) *Aedes aegypti* – Yellow Fever Mosquito

Of some historical interest -- breeds almost exclusively in man-made containers around human habitations, has a short flight range, strongly prefers human blood meals over other mammals; susceptible to cold winters, so not normally found north of the Carolinas, but during colonial times in summers could be found in port cities as far north as New England, in association with coastal shipping; notorious vector for yellow fever, with a yellow fever epidemic in Philadelphia in 1793 killing about 10% of the city’s population and sickening twice that many. Also major vector for dengue fever in the Caribbean and Latin American countries, and in southern Texas and southern Florida too. Of particular concern if global warming allows its range and populations to expand northward in U.S.

B. Pest Management Areas

Almost Everywhere!

Essentially for mosquito control purposes, our pest management area is the entire State of Delaware, being about 1954 square miles (1.25 million acres) in size not including the state-owned open waters of Delaware Bay, containing many types of water bodies (including wetlands) in numerous locations around the state that can and do produce excessive or intolerable amounts of mosquitoes. Problematic numbers of mosquitoes are produced in both the Piedmont and Coastal Plain regions of the state, with the more expansive or severe mosquito production areas being in the Coastal Plain, although there are still numerous problem spots in the Piedmont too. The Interstate 95 (I-95) corridor can serve for an approximate delineation boundary between Coastal Plain and Piedmont regions.

Problematic mosquito production waters in Delaware can occur in jurisdictional waters of the U.S., in jurisdictional waters of the State, or in non-jurisdictional waters. This applies to all of Delaware’s 45 watersheds, where any-and-all could receive mosquito control insecticide applications during any given year. Because of the expansive, numerous and often inter-connected nature of surface waters that have to be treated with mosquito control larvicides, or that might be exposed to mosquito control adulticides, it is impracticable if not impossible to discriminate between these 3 types of waters (waters of U.S., or waters of the State, or non-jurisdictional waters) when undertaking mosquito control spray operations, nor would the Mosquito Control Section want to do this or see any value in doing such. Essentially, treatments have to be made wherever it’s necessary as driven by environmental conditions to deal with excessive or intolerable numbers of mosquitoes, whether they be larvae or adults, done without any regard to the jurisdictional nature of surface waters for their being regulated or not for whatever purposes.

Enabling Authority for What Gets Treated

The Mosquito Control Section applies mosquitocides as needed to or over state-owned, county-owned, municipal-owned, or privately-owned lands throughout Delaware in accordance with Delaware Code Title 16 (Health & Safety), Chapter 19 (Mosquito Control), Sections 1901-1905. Mosquito Control Section staff can statutorily enter upon any-and-all lands without permission from or advance notice to landowners to inspect for any problematic larval or adult mosquito populations that might occur, and then treat any problematic mosquito populations encountered with proper means doing no unnecessary damage, accomplishing this without any notification to land owners before or after treatments (and in a most practicable sense, the Section really must work this way to effectively function, or we'd never get our jobs done in efficacious, cost-effective manner, which State law wisely recognizes and then accommodates for our access authority).

Working on Federal Lands

Such statutory ability and latitude for the Mosquito Control Section to work also applies in practice to many federal lands in Delaware (e.g. Army Corps of Engineers dredge spoil sites, U.S. Post Office facilities), with lone exception here for federal National Wildlife Refuges managed by the U.S. Fish and Wildlife Service (USFWS). Mosquito control practices routinely undertaken by the Mosquito Control Section on Bombay Hook NWR and Prime Hook NWR in Delaware are defined and described by the USFWS via annual Special Use Permits (SUPs) issued to the Section each year for larvicide or adulticide spraying on each refuge, which is then done in accordance with Special Conditions set forth by the USFWS in each SUP. Also note that the Mosquito Control Section doesn't have routine cause to work on military bases or facilities in Delaware (e.g. Dover Air Force Base, National Guard properties, military Reserve unit facilities), but when such rare need might arise either as requested by a federal military facility or as recommended by the Mosquito Control Section, the working arrangements in terms of site access and permissible treatments are handled on a case-by-case basis.

A Wide Range of Treatment Areas and Sites

Mosquito control larvicides can be directly applied into or run into any waters of the State; or mosquito control adulticides can be applied nearby or over such water bodies via spraying in upland or wetland areas, or mosquito control adulticides can drift as spray clouds over such waters following applications in nearby or even distant upland or wetland areas. All of these forms of mosquito control treatments are necessary or allowable types of applications to or over surface waters, permissible under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). This type of latitude when applying mosquito control insecticides must be allowed in order to efficaciously and cost-effectively abate a severe problem if not controlled.

Due to the literally tens-of-thousands of “pest management areas” or the literally hundreds-of-thousands of “discrete treatment sites” associated with literally thousands of mosquito control spray events performed each year by the Mosquito Control Section, any attempt to definitively delineate this universe *in advance* would be a futile exercise and really of little practical value to anyone, but the amount of work to try to do this would be monumental and quite poor return-on-investment. However one might define and delineate “pest management areas” or “discrete treatment sites” would also be a very problematic undertaking to enumerate or show statewide just for larviciding purposes, let alone for adulticiding. This is due to the expansive and pervasive nature of many types of surface waters throughout Delaware that produce problematic numbers of larval mosquitoes, or for which either nearby or over such waters problematic numbers of adult mosquitoes can be found. Additionally, the universe of such areas or sites and the extents or intensities of treatments can readily change from year-to-year, in response to a whole host of environmental conditions and man-made factors too.

It would be major folly to try to accurately predict or definitively show such areas or sites in advance of any treatments each year, particularly relative to any permit-regulated uses or applications that could then have legally binding consequences. However, at the end of each mosquito control year, it wouldn’t be wildly unreasonable to ask for an accounting at least in a general sense, and for some types of treatments even in a pretty specific sense, including electronic provision of spray cover maps for each spray event if desired, for where mosquitocide spraying or treatments had actually been done around the state, given the Mosquito Control Section’s use of GPS/GIS tracking methods and other modern-day technologies. Doing this on statewide basis as some type of comprehensive annual wrap-up would admittedly be a lot of work to do, but if the Mosquito Control Section is given enough additional staff and resources coming from somewhere, probably something could then be done.

The Annual Extent of Mosquitocide Treatments Around the State

It’s possible to provide an indication for how much mosquito control spraying might occur statewide when realistically viewing the entire state as our pest problem or management area, at least in terms of average amounts applied during the mosquito control year (which usually starts in mid-March and lasts until mid-October, but in some unusually warm autumns can extend into early November). Please note that average and maximum numbers presented below also reflect a certain amount of repeat applications of mosquitocides to or over given areas or sites throughout the mosquito control year, and are thus cumulative numbers that reflect possible repeat applications to any given area or site (possibly involving up to about 6-8 larvicide applications to a given area or site within a year, and possibly up to about 4-6 adulticide applications near or over a given area or site within a year, with all frequencies or timing for applications done in accordance FIFRA-based product label stipulations).

- Aerial adulticiding (by fixed-wing aircraft or helicopter), statewide average = 53,000 acres/year (maximum acreage aerially adulticided during any given year can be >200,000 acres), being a combination of upland, wetland and water habitats.

- Ground adulticiding ("fogging" by truck), statewide average = 62,000 acres/year (maximum acreage ground adulticided during any given year can be >125,000 acres), being a combination of upland, wetland and water habitats.

- Aerial larviciding (by fixed-wing aircraft or helicopter), statewide average = 22,000 acres/year (maximum acreage aerially adulticided during any given year can be >50,000 acres), being a combination of wetland and water habitats. Note: these figures for aerial larviciding reflect in part about 7000-10,000 acres of wet woodlands treated each spring for early season woodland pool larval control.

Given the extensive areas treated each year by the Mosquito Control Section involving myriad sites and locations however such might be defined, any annual reporting of our mosquitocide use will involve compilations on an event-by-event basis of where treatments were done (which can be shown as GIS-generated maps), along with provision of event-specific metadata such as product used, rate of application, mode of application, total acreage or linear distances treated, etc. However, due to the amount of work involved and any true value added, it will not be possible when annually reporting to then *routinely* breakdown or further describe the area sprayed for any given treatment event in terms of its various surface cover types (e.g. wetlands of various types, surface water bodies of various types, uplands of various types, etc.), or to provide acreages or linear distances treated for each type.

Types of Aquatic Habitats Needing Mosquito Control

A more meaningful and really a much more doable, realistic approach to describing potential pest management areas is to take a more qualitative, habitat-based one, starting with recognizing that larviciding will not occur without some type of larval population threshold criteria having been exceeded, and that adulticiding will similarly not occur without some type of adult mosquito population threshold criteria having been exceeded, regardless of whatever types of habitats might be involved (these action threshold criteria are discussed in some detail in the Section II-D of the PDMP). Then depending upon the types of mosquitocide products being used, and in accordance with what appears on the FIFRA-regulated product labels, any given mosquitocide product will only be applied to or over habitats or locations permissible per whatever the product label says.

Pest problem areas for mosquitoes in Delaware necessitating treatments can best be separated into 3 broad environmental groups, which can then be further divided based upon specific habitats types or niches. In viewing this compilation below, it's apparent how expansive and pervasive mosquito production problems can be in Delaware, especially when paired with the accounting for target mosquito species of concern that's presented in Section II-A of the PDMP.

1) Coastal Wetlands

   a) Tidal salt marshes along the lower Delaware River and Delaware Bay, around the Inland Bays, or in the Nanticoke River watershed.

b) Tidal brackish-water marshes along the lower Delaware River and Delaware Bay, around the Inland Bays, or in the Nanticoke River watershed.

c) Tidal or non-tidal freshwater marshes along tributaries to lower Delaware River or Delaware Bay, or around the Inland Bays, or in the Nanticoke River watershed.

d) Diked coastal impoundments, with interior water levels and tidal exchanges often managed via water control structures, primarily along the lower Delaware River and Delaware Bay, and to lesser extent around the Inland Bays.

e) Coastal intra-marsh islands or hammocks.

f) Coastal marsh-upland transitional zones or ecotone areas, shrubby coastal marsh upland edges.

g) Coastal interdunal ponds or swales.

h) Coastal dredge spoil sites or containment areas.

2) Freshwater Wetlands or Inland Aquatic Sites

i) Riverine floodplains covered by emergent wetlands vegetation, shrubs, or trees such as red maple, black gum or cypress.

j) Freshwater emergent marshes dominated by grasses, sedges or rushes, often with shrubby margins.

k) Vegetated margins or edges of lakes, natural ponds, millponds, or reflection/ornamental ponds.

l) Coastal plain ponds or Delmarva bays.

m) Woodland ponds, pools or depressions, including vernal pools, either in wetland forests or forested uplands.

n) Bogs and swamps.

o) Meadow swales, old field depressions.

p) Other smaller natural environments including small springs, hillside seeps, tree holes or cavities, overturned or toppled tree stump holes, wildlife burrows.

3) Man-made Environments (often in urban/suburban/exurban areas, including various types of “container habitats” in the broadest sense)

a) Roadside ditches.

b) Canal or channel edges, including along stormwater drainage canals or ditches, or along agricultural drainage ditches (“tax ditches”).

c) Borrow pits.

d) Landfills, garbage dumps.

e) Scrap tire piles.

f) Junkyards.

g) Clear-cuts from logging operations for timber harvest or land development projects. Often such work scars the land with trenches and ruts from the heavy equipment use, creating water-holding low spots.

h) Livestock pastures often have numerous wet spots from hoof prints, becoming prolific mosquito breeders.

i) Man-made or created wetlands (often associated with wetlands mitigation projects).

j) Stormwater management ponds, with both detention and retention ponds presenting mosquito production problems depending upon how they're designed, constructed and managed (or not managed).

k) Stormwater or street sewer drains, sewer catch basins -- primarily in cities and towns.

l) Wastewater or sewage lagoons.

m) Water-holding containers in all sorts of shapes and sizes, primarily associated with urban/suburban/exurban development involving residential, commercial or industrial properties, but can also be problematic around farm buildings or at animal husbandry sites – e.g. open containers, buckets, and cans of various sorts, open dumpsters, uncovered cisterns or rain barrels, animal watering troughs, upturned trash can lids, discarded or used tires, clogged rain gutters, downspout extenders that don't fully drain, unused bird baths, belowground or aboveground abandoned swimming pools, kiddies plastic swimming pools, flower pot liners, upright wheelbarrows, depressions in tarps covering boats, etc.

C. General Location Map

No maps are provided in the PDMP since they would be rather meaningless in terms of where we might need or have to treat during any specific year, given the expansive nature and great diversity of larval mosquito production habitats and adult mosquito occurrence habitats that we have to contend with statewide as described above, and whereby treatment areas or sites can readily change from year to year, month to month, week to week, or day by day. The only map that we could provide would be one of literally the entire state of Delaware, hence a seemingly meaningless inclusion.

For anybody who might be interested in where jurisdictional wetlands of the U.S. or jurisdictional wetlands of the State are located in Delaware, of which there are *many* jurisdictional areas and sites, and which in part then contribute to our statewide universe of potential treatment sites, DNREC Division of Water's Wetlands and Subaqueous Lands Section has such maps available for public access and viewing (for further information, go to:

http://www.dnrec.delaware.gov/wr/Services/Pages/WetlandsAndSubaqueousLands.aspx.

At the end of any given mosquito control year, copious numbers of detailed GIS-generated maps could theoretically be provided for locations where we had actually treated during the past year, either for larviciding or adulticiding by ground or air, involving tens-of-thousands or even hundreds-of-thousands of treatment areas or sites. Within reason and if need be in our providing any required Annual Reports of our mosquito control treatments, we could provide at that time whatever maps might be requested by a regulatory agency ***if*** logistically feasible to produce on our part, given our staffing levels and working resources, and in view of the other core functions that we also have to meet. Please understand that we could always produce a limited number of specific maps for our treatment efforts to meet on a case-by-case basis specific requests for such maps as they might arise; but our alternatively possibly producing many maps of our annual treatment areas and sites just to sit in a regulatory agency's digital vault, with our possibly having to do such at considerable labor and expense to our program and hence the State, would seem like a very poor return-on-investment.

Please also note that when the Mosquito Control Section works on federal National Wildlife Refuges at Bombay Hook or Prime Hook NWRs, the Section in accommodating a USFWS request provides several maps to the Refuge Manager specific to each NWR where the Section wants or needs to perform larvicide or adulticide treatments on-refuge each year, which upon approval by the Refuge Manager then become part of the Special Conditions attached to annual Special Use Permits (SUPs) that the USFWS issues to the Section each year for larviciding or adulticiding on-refuge. Since in comparison to our statewide universe of possible treatment sites, our targeted treatment areas on Delaware's two NWRs are relatively small, this is doable task for the Section. But it would be an impossible task to fulfill with any specificity if we were required to do something similar for all other possible treatment areas or sites around the state.

D. Action Thresholds -- Mosquito Population Monitoring/Spray Threshold Criteria

What Type of Monitoring is Involved in Making Spray Decisions?

Determination of when and where mosquito control insecticide spraying might be needed, whether for larvicides or adulticides, is based upon extensive and intensive *surveillance-and-monitoring* efforts for immature or adult mosquito populations using several types of indicators for larval or adult mosquitoes, as well as sometimes indications of the presence in the environment of mosquito-transmitted viruses of special concern to human health (e.g. eastern equine encephalitis, West Nile virus). No one factor is always decisive for when or where to spray, and often a combination of quantitative and qualitative data must be evaluated to make “spray/no-spray” decisions in quasi-subjective manner (including also factoring in current or predicted future conditions for weather or tides that affect windows-of-opportunity for when spraying might best be done).

What Does It Mean to Exceed Threshold Values?

A long history in Delaware (>45 years) of our “real world” experiences in developing and using the threshold criteria below indicates that when a criterion or combination of criteria are exceeded and we do not initiate some control actions by larviciding or adulticiding as appropriate, then mosquito infestations of a level unacceptable to the public’s quality-of-life, comfort and well-being, and often detrimental to local economies too, will either soon ensue or will continue unabated. Additionally, if these infestations are not satisfactorily prevented or controlled, there can then often be corollary substantive concerns about potential public health risks and problems in the form of mosquito-borne diseases. Therefore, the numeric values for the thresholds provided below are always subject to further refinement or modifications by the Mosquito Control Section as circumstances or new information warrant, in that these criteria have evolved over time and will probably continue to do so.

What Mosquitoes Need Control?

By no means do all mosquitoes in Delaware need control, since of the approximate 57 mosquito species found in the state, only about 19 species are pestiferous or problematic to humans or domestic animals, and which were described in Section II-A of the PDMP. Factors in determining how pestiferous a mosquito species might become include how abundant or numerous can the adult populations of these species be, and what are their flight ranges, host preferences, biting aggressiveness, or potential for transmitting diseases. Contending with one or more of these 19 pestiferous species results in mosquito control spraying in Delaware that routinely starts about mid-March with larviciding for spring woodland-pool-breeding species, then progresses to salt marsh larviciding starting as early as April in some years, with adulticiding of saltmarsh mosquitoes sometimes also needed as early as mid-April, and then continuing with various types of spraying around the state throughout the remainder of the control season up until as late as early November, including efforts to suppress container-breeding species in urban or domestic settings, and the control of mosquito production in myriad freshwater habitats.

Who Determines the Threshold Criteria?

By State statute, the Mosquito Control Section has the responsibility and authority for determining and using these threshold criteria for making decisions about when and where mosquito control spraying is *needed* for any-and-all lands in Delaware, whether the lands are federal, state, county, municipal or private properties. This is not necessarily one-in-the-same as determining when and where spraying will actually be *allowed* to be done (e.g. on federal National Wildlife Refuges), or will be acceptable for any given landowner. Nonetheless, in order to treat public nuisances or prevent disease, the Mosquito Control Section has the statutory authority to enter upon all lands under the State's jurisdiction including private lands (with federal NWRs of course not under the State's jurisdiction), and take whatever control actions are needed while doing no unnecessary damage, including spraying or applying mosquitocides without landowner permission or concurrence, which is a practicable allowance under State law that we need in order to efficaciously get the job done in cost-effective manner; but for any source reduction projects involving physical habitat modifications (e.g. an Open Marsh Water Management project), we almost always try not to exercise such legal authority to impose our will, and hence rarely ever undertake these source reduction projects without the cooperation or consent of landowners.

Threshold Criteria for Application of Larvicides:

Wetland or "Pothole" Larval Dipper Counts (applicable to saltmarsh or freshwater wetlands *pestiferous* species) – for larval dipper counts (using basically a coffee-cup-size container on a stick designed to take shallow-water samples), where larvae can range from 1st to 4th instars and also include pupae, our finding any larvae in >25% of all sampled sites that then average >5 larvae/dip (for all dips, including "zeros") can warrant larviciding throughout the wetlands where the sampling runs were performed. Thus, these threshold criteria incorporate minimum triggers for both the spatial extent or frequency of any breeding observed (>25% of sampled sites), and for the intensity or amount of any breeding observed (average >5 larvae/dip) – i.e. for any larviciding to occur in a sampled marsh or wetlands, breeding must be observed in >25% of all the breeding sites sampled, AND be occurring at an average intensity of >5 larvae/dip (incorporating all dip counts including zeros into this average). Additionally, for saltmarsh breeding leading to larviciding efforts, an additional factor is added whereby >25% of the marsh surface in "tussocky" salt marshes, or >25% of pothole habitats in firmer salt marshes, must be estimated to be inundated or holding water, as a measure of the extent of potential breeding habitats actually holding water. [An estimate of the % pupae present in saltmarsh or freshwater breeding habitats also gives us an indication as to whether it might be too late to attempt effective larvicide treatments.] Experience has shown us that if we don't take timely larviciding actions before a mosquito brood of such problematic scope or intensity emerges, then it will be a matter of only a few to several days before adulticiding will then become necessary, in either nearby or even quite distant locations depending upon the types of mosquito species involved, along with weather factors such air temperature or wind speed and direction.

Larval Sampling Stations -- Larval sampling stations are described in our larval sampling plans, or are given as larval inspection instructions specific for given areas, provided by our Section managers to our field personnel so that timely and good spatial representation of potential breeding sites is achieved, with the sampling sites selected having environmental characteristics known or thought to favorable for mosquito-breeding. By recent rainfall or tidal flooding patterns, we usually have a pretty good idea of the best timing to undertake our larval surveillance efforts to yield the best-return-on-effort. Refinements for the need to larvicide any geographic area or location where observed breeding exceeds threshold criteria can be made, based upon the types of mosquito species found and their typical flight ranges, as well as a breeding site's proximity to human population concentrations, sometimes resulting in our not taking larval control actions even though threshold criteria are exceeded. For example, long-distance-flying saltmarsh mosquitoes (often roaming 5-15 miles from their natal marshes) will typically warrant larviciding anywhere the breeding threshold criteria are exceeded; whereas some relatively short-distance-flying freshwater species (flying from only a few hundred yards up to 1-2 miles from their natal habitats) might not, especially in areas remote from human populations.

Larval Identifications -- The levels to which larval identifications need to be taken for operational purposes can vary depending upon the environmental setting and the operational utility of making such taxonomic identifications. For example, in salt marshes all 5 saltmarsh mosquito species encountered in Delaware are known to be problematic for humans, so for salt marsh surveillance any-and-all larvae can be of concern, and just counting larvae without regard to specific species suffices for most operations, which is especially true for the 3 salt marsh *Ochlerotatus* species that dominate open saltmarsh mosquito production, and to a lesser extent for the single *Culex* and single *Anopheles* species found in salt marshes. The saltmarsh *Culex* and *Anopheles* species are more commonly associated with impounded or more permanent-water breeding habitats in our coastal wetlands, and also don't fly as far as the 3 *Ochlerotatus* species, so unless populated areas are within 1-2 miles from where saltmarsh *Culex* or *Anopheles* larvae are detected, in most cases it wouldn't be necessary to larvicide impounded or more permanent water saltmarsh habitats (that also lacked significant *Ochlerotatus* breeding). Fortunately, it is relatively easy to distinguish in the field among *Ochlerotatus, Culex* and *Anopheles* larvae at the genus level when doing dipper counts. In most freshwater environments, particularly in wet woodland pools, meadow swales or roadside ditches, finding and identifying in the field the larvae of *Ochlerotatus, Aedes* or *Psorophora* genera can indicate a problem regardless of species; and when populated areas are found within 1-2 miles of such freshwater breeding habitats, so can finding and identifying in the field larvae of *Culex* or *Anopheles* genera regardless of species. Finding larvae of *Ochlerotatus, Aedes, Psorophora, Culex* or *Anopheles* genera regardless of species in or near populated areas, whether the larvae are found in standing water, ephemeral water, or container-breeding habitats (including for the latter any man-made structures holding water for more than 4 consecutive days, or in natural treeholes), can all be problematic. Overall here, for operational purposes in almost all types of breeding habitats, identifying larvae in the field just to the genus level quite nicely suffices. Finally, it should be noted that finding larvae of *Coquilletidia perturbans* can also be indicative of a problem situation, but because of their larval requirements for burying into sediments and attaching to rooted aquatic vegetation, these larvae are rarely observed in the field without purposely sampling for them, and such larval habitat also does not lend itself to larviciding, so adulticiding becomes the primary form of control for this species.

“Container” Occurrences (applicable to larvae of *pestiferous* species found in natural or man-made containers or other water-holding structures) – any larvae of *pestiferous* species (genera) observed in or sampled from container-like habitats might warrant control, especially if close to human habitations and standing water will remain for more than 4 consecutive days. Primary species of concern will be those found in genera *Culex*, *Ochlerotatus* or *Aedes.* If the “containers” lend themselves to dipper sampling, then larval counts averaging >2 larvae/dip might warrant control actions. If larval control cannot be achieved by source reduction (e.g. dumping or eliminating standing water), then larviciding might be needed, almost always done via ground- or hand-applications (exceptions here involving aerial applications might occur for salvage yards, tire dumps, or sewage lagoons), although trial efforts are now underway to see if it might be practicable to address some “container” breeding habitats via ground applications or aerial larviciding using helicopters.

Threshold Criteria for Application of Adulticides

Landing Rate Counts (applicable to adult biting mosquitoes landing on a field inspector during a one-minute period either in or nearby human habitations or within flight ranges of human population concentrations, with the counts taken anytime between early morning through early evening) – in populated areas (such as cities, towns or suburbs, or in exurban subdivisions or larger strip-developments**)**, landing rate count averages for biting mosquitoes of >2-3 mosquitoes/minute (translating into 60-90 or more mosquito bites in a half-hour in somebody’s backyard) can trigger the need for adulticiding; whereas in relatively unpopulated areas (often rural locations with low population densities, and commonly in or near wet woodlands or marshy staging areas), landing rate averages for biting mosquitoes of >5-10 mosquitoes/minute (becoming 150-300 or more mosquito bites in only a half-hour) might be needed to warrant adulticiding. [In some locations at certain times, landing rate counts of 50-100 mosquitoes/minute have been recorded.] The results obtained with landing rate counts can be almost immediately diagnostic of any need to adulticide.

How to Perform Landing Rate Counts -- The protocol for conducting landing rate counts consists of counting all mosquitoes observed landing on all readily visible parts of an inspector’s body in one minute intervals, with the inspector standing still and making very little movement, along with not using any type of repellent. At any particular site, specific sampling or standing locations for conducting the counts are selected favoring shaded spots near vegetation having little or no wind. When it is obvious that a landed mosquito is either biting or about to bite an inspector, the inspector is allowed to undertake subtle movements during the count to terminate or prevent the bite (which makes for very interesting movements when dozens of mosquitoes might be simultaneously trying to bite); and care is also taken to the extent possible not to count any single mosquito more than once during any one-minute count.

When to Take Landing Rate Counts -- Because of normal working hours for State employees, most landing rate counts are conducted during the daytime, which in allowing for commuting time then leads to most counts being conducted in the field between about 8:30 am and 4:00 pm. This can work well for saltmarsh and wet woodland *Ochlerotatus* spp., for freshwater *Psorophora* spp. and *Aedes vexans*, and for the container-breeding *Aedes albopictus*, but often tends to underestimate the abundance on-wing that'll be found in the early evening, throughout the night, or early in the morning for *Culex* and *Anopheles* spp., and to a lesser extent for *Coquilletidia perturbans.* Whenever possible and practicable to do, particularly where pertinent for dealing with potential "hot" situations, landing rate counts are also conducted near or at dusk or in the early morning by Mosquito Control staff. It can be safely assumed that any mosquito landing upon an inspector is one of the 19 problematic species, and hence any-and-all mosquitoes observed alighting during a landing rate count are included in the tally.

New Jersey-style Adult Light Trap Counts (collected via unbaited NJ adult light traps at a few dozen "permanent" locations around the state, typically set within populated areas, or sometimes set in locations indicative of potential problems for nearby populated areas) – having nightly NJ adult light trap counts containing >25 females/trap of *pestiferous* species, checked the following day after a night's trapping period, or which average >25 females/trap of pestiferous species for multi-night collections, are indicative of adult mosquito populations on-wing in the general vicinity that would have been intolerable to most people the night(s) before. Because of the lag time involved with collecting and analyzing adult light trap collections, these counts often are not as immediately diagnostic of any need to adulticide as are landing rate counts; but within about 48-72 hours of problems arising from excessive numbers of adult *pestiferous* mosquitoes on-wing, the light trap counts can serve as indicators of the need to adulticide. However, even with such a delay in immediate operational utility, the light trap counts are still valuable for allowing us to examine many of the types of *pestiferous* mosquitoes that might be around, at least for the trap-susceptible species, allowing for year-to-year comparisons at any given location and month-to-month comparisons within any given year. They can also help with assessments of our control efficacies.

CDC-style Portable Adult Light Trap Counts (collected via CO_2-baited portable CDC adult light traps at temporary collection stations around the state, often set and tended in location types similar to where NJ adult light traps are deployed, and often set in response to other indicators of mosquito problems, particularly to determine or to verify "hot spots") -- nightly CDC adult light trap captures collected the following day containing >50 females/trap of *pestiferous* species are indicative of adult mosquito populations on-wing in the general vicinity that would have been intolerable to most people the night before. [The CO_2-baited nature and other inherent design features of the CDC-style traps cause them to collect more mosquitoes per night than NJ-style adult light traps, but the NJ-style traps are more durable and less costly to operate than the CDC-style traps, and the Mosquito Control Section also has a much longer historic database using NJ-style traps at well-established, fixed locations.] Because of the urgency with which these portable CDC-style traps are often set and tended to and then analyzed, they can be diagnostic of the need to adulticide within about 24-36 hours of their setting.

Public Complaints About Biting Mosquitoes – these are called into or otherwise communicated to either our upstate or downstate Mosquito Control Section operational headquarters (in Glasgow for New Castle County and northern Kent County; and in Milford for southern Kent County and all of Sussex County) by citizens or elected officials, and usually involve people wanting to report or complain about unacceptable or intolerable numbers of biting mosquitoes on-wing, followed by their then requesting some adulticiding (although sometimes the reports involve concerns about observations of standing or stagnant water bodies that might produce mosquitoes, which they either want us to inspect and treat with larvicides or to somehow eliminate). Receiving complaints from the public is an invaluable way to help us focus and make best use of our limited control resources – depending upon weather conditions and other environmental factors during any given year, on a statewide basis the Mosquito Control Section typically receives from about 1500-3000 public complaints about too many biting mosquitoes, conveyed to us from early April into early November. In some years in the aftermath of a hurricane, for the 3-4 week period following the storm's passage public complaints statewide can amount to >2000 calls.

Reactions to Public Complaints -- Depending upon patterns for the geographic locations, densities and intensities of public complaints received, the Mosquito Control Section might then undertake some adulticide spraying. When practicable to do within limits of our staff availability and working resources, and before making any final decision to spray just based upon public requests, we often try to integrate these calls for treatment with other available mosquito-problem indicators, such as landing rate counts or adult light trap counts. Over the period of many years of our doing this, we have also come to know many individuals whose requests for some adulticiding relief to suppress local mosquito populations are unfailingly accurate and representative of truly intolerable quality-of-life conditions caused by too many biting mosquitoes, and we tend to pay extra attention to many of these regular "trusty" callers. We also take quite serious any requests from city or town officials for our adulticiding services, for those municipalities that have endorsed our annual Spray Policy's requirements and protocols. And to repeat here, whenever possible to do, our responding to public complaints by actually spraying is to the extent practicable also first coupled with other indicators of adult mosquito abundances, including landing rate counts or adult light trap counts pertinent to the areas where adulticiding requests have arisen. Some deviation from being able to adhere to this protocol occurs relative to early season woodland pool adult mosquitoes, where due the time of year and not yet having our summer seasonal employees aboard creates some staffing limitations, affecting our ability to run an adult light trap program or to undertake many landing rate counts, such that almost all of our adulticiding efforts for these early season woodland pool species through to late May is primarily complaint driven.

Indicators of Mosquito-Borne Diseases

The Mosquito Control Section conducts surveillance-and-monitoring for mosquito-borne diseases of note to humans that in Delaware primarily concerns two arboviruses -- eastern equine encephalitis (EEE) and West Nile virus (WNV).

Sentinel Chickens -- The Section operates a statewide network of a few dozen "sentinel chicken" monitoring stations each year, whereby from about early June into late October about one-half of our sentinel birds are tested every week for the presence of antibodies indicative that they have might contracted EEE or WNV, yielding for us a good signal of the viruses' presence and transmission within the environment. The sentinel chicken flock locations are selected to give us good geographic coverage (or at least as much as we can afford) for general areas either known or suspect to have good virus potential. Each sentinel chicken station (or "flock") consists of 4 birds that are humanely housed and cared for in wire mesh cages, with 2 birds each week from each station having blood drawn for virus testing, thereby causing any individual chicken to be sampled but once every two weeks. The bleeding does not kill or harm the birds, and any chickens that might contract EEE or WNV also do not die from these viruses.

Sick or Dead Wild Birds -- The Mosquito Control Section also operates from May through October a statewide network for collecting and reporting sick or dead wild birds suspect to have WNV, relying primarily upon public reports of suspect wild birds, collection of good candidate specimens by the Section, and testing for the presence of WNV by the state's Division of Public Health Laboratory. Bird species of primary interest include crows, blue jays, cardinals, robins, hawks and owls. The Section has a statewide geographic strategy for accepting and testing wild birds that helps to ensure good spatial coverage and timely monitoring.

Mosquito Collections -- Occasionally on an *ad hoc* basis, the Mosquito Control Section will also analyze mosquito collections (or mosquito "pools") for the presence of WNV or EEE, sometimes with an interest in the specific species of mosquitoes possibly carrying the viruses, or sometimes with only a more general interest in documenting the presence of viruses at the genus or guild levels. Samples for such analyses are usually collected by portable adult light traps. This might be done in conjunction with or as follow-up to other indications of virus presence, particularly in known or suspect virus "hot spots."

Horse/Human Cases -- The Mosquito Control Section also receives timely reports from the State Veterinarian for the finding of EEE or WNV in unvaccinated horses; and we receive from the state's Division of Public Health timely reports of any EEE or WNV human cases. All such reports are handled by the Section with utmost confidentiality.

What Does Presence of Virus Mean? -- Indications of the presence of EEE or WNV by any of the methods above is then to some extent factored both spatially and temporally into the types and extent of control actions that we take. In part we use such indications to try via press releases and other media contacts to increase the public's awareness to take some personal protection measures against being bitten, and for people to also practice good water sanitation around their homes or businesses to reduce mosquito production. We also use such virus indications to increase to the extent possible and practicable our surveillance-and-monitoring actions for assessing local mosquito populations, and to increase our mosquito control treatment efforts accordingly, since one of the more important factors in preventing mosquito-borne diseases is to reduce even further populations of bridge-vector species, in order to decrease the probability even further that people will get bit by disease-carrying mosquitoes -- i.e. ***good nuisance control = good disease prevention!*** This increase in our control responses relative to findings of virus presence is typically achieved by our then *reducing* the spray threshold criteria associated with indicators of mosquito abundance from their somewhat higher levels when there's no immediate indications any mosquito-borne diseases, in that we then undertake spray actions at *lower* larval dipper counts, *lower* landing rate counts, *lower* adult light trap counts, *lower* numbers of public complaints, etc. than what have been indicated above for our typical or base thresholds when there are no indications of disease. By how much we actually lower these threshold criteria in response to virus presence is fairly subjective, based upon our semi-quantitative estimations of virus presence; but since *human health* is involved here, we of course tend to err-on-the-side-of-caution (and within limits of our available treatment resources).

Please note that in areas where mosquito-borne diseases such as EEE or WNV are historically well known to be a well-established part of the environmental landscape (i.e. these pathogens are enzootic/endemic), such as throughout Delaware, our then trying to quantify or refine the presence or occurrences of arboviruses via field sampling of various types, and to then somehow possibly try to tightly link such arbovirus measures to mosquito population abundances for vector species of concern, all possibly done to then try to derive some type of hybrid quantitative index before possibly taking mosquito control actions, would be a bit misleading at best, and more typically and really quite alarmingly also some poor public health management. This is because due to many practicable, logistical, scientific and technological reasons, it's really not possible to quantify the presence or occurrences of arboviruses with a high enough degree of certainty at any given time or in any given area to then provide much comfort to anyone that perhaps some intolerably high numbers of biting mosquitoes still wouldn't warrant control (during times when indications of arboviruses might be low), leading to a false sense that there might then be diminished threat of disease transmission despite many biting adult mosquitoes on-wing. Quite realistically, these arbovirus sampling efforts simply don't yield the types of data from either quantitative and qualitative perspectives where you could confidently say that mosquito-borne pathogens aren't present in the environment, or if present are only there at low levels of little concern, and you especially wouldn't want to make such assumptions in areas where arboviruses are historically known to be enzootic/endemic, such as throughout Delaware. [And of course managing this way based only upon the trying to detect various levels of arboviruses in the environment relative to specter of mosquito-borne disease transmission doesn't address the very real need to also control mosquito populations in terms of their adverse impacts to human health even without any pathogen or disease transmissions, stemming from various human health problems associated with simply receiving too many mosquito bites per se, nor the need to also control mosquitoes for important quality-of-life and socio-economic reasons.]

One should note that for frontline operational mosquito control programs, the detection of arboviruses in our sentinel chickens, or in wild birds, or in mosquito collections doesn't then automatically lead to our spraying larvicides or adulticides, in that whatever we might locally do in manner of any follow-up treatments also first needs to have thresholds exceeded for local mosquito population abundances, since why spray if vector population abundances don't warrant such? (i.e. no matter what some arbovirus measures might be indicating, you still wouldn't be applying larvicides to treat waters where larvae were absent or present in only very low numbers, nor spraying adulticides to treat areas where adult mosquitoes couldn't be found or perhaps were present only at very low levels). However, this does ***not*** work the other way around – i.e. when mosquito populations might become too large, especially for bridge-vector species-of-concern in areas where arboviruses are historically enzootic/endemic, you would then want and need to quickly treat with larvicides or adulticides when mosquito population thresholds are exceeded, no matter how low or absent the indicators of arboviruses might be in sentinel chickens, wild birds, or mosquito collections.

The need to err-on-the-side-of-caution relative to mosquito-borne disease threats, particularly where arboviruses are historically enzootic/endemic, then prompts almost all modern mosquito control programs around the country to manage primarily based upon indications of mosquito population abundances for vector species of concern, and to take actions when certain mosquito population thresholds are exceeded, *without* any dubious effort to also couple such mosquito population thresholds with other types of arbovirus measures that one might be able to take or conjure up (whether such arbovirus measures be in a temporal sense recent or simultaneous measures, or be in a spatial sense nearby or even distant measures). Thinking that one could do this type of hybridization of measures involving arbovirus presence paired mosquito population abundance in any meaningful fashion for making frontline decisions about control operations, especially when and where public health could be at risk, and especially in areas such as Delaware where diseases such as EEE or WNV are enzootic/endemic, would be a bit delusional, and more damningly also irresponsibly "roll the dice" for protecting public health. Rather what is done here in the real world is to simply undertake mosquito control actions whenever populations of mosquito species-of-concern become too large, exceeding established thresholds. This has proven over time in many areas of the country to be the most practicable, efficacious, cost effective way to work, in order to then realistically deal with mosquitoes and their myriad problems.

E. Water Quality Standards [relative to Tier 3 or Section 303(d) waters]

There are no Tier 3 (Outstanding National Resource Waters) in Delaware, so there are no problems relative to any mosquitocide applications to such waters, since they don't exist in our state. There are also no Section 303(d) impaired waters in Delaware that are so designated due to any modern-day mosquitocide products that the Mosquito Control Section currently uses (although there might be such impaired waters designations from "legacy" pesticide products such as DDT). As such, there are no problems relative to any modern mosquitocide applications presently made to any impaired waters in our state.

III. <u>Pest Management Options Evaluation</u>

A. Taking an Integrated Pest Management (IPM) approach

What follows are descriptions of mosquito control measures and practices demonstrating how the Mosquito Control Section plans to meet applicable technology-based (TBEL) or water quality-based (WQBEL) effluent limitations. But first it's important to recognize that the Delaware Mosquito Control Section takes an Integrated Pest Management (IPM) approach to go about our necessary business of controlling mosquitoes, and whereby IPM in its specific application for mosquito control purposes is sometimes also known as Integrated Mosquito Management (IMM). IPM for mosquito control involves a combination of pest prevention or control methods, including in part source reduction approaches involving practicing good water sanitation around residences, businesses or industrial sites, or implementing various water management techniques or practices in natural or man-made settings, or performing larval habitat modifications, or introduction and use of biological control agents, or utilization of EPA-registered insecticides to control larval or adult mosquitoes, or public education and outreach.

Please note that IPM does ***not*** mean that no insecticides could or should be used (as IPM is sometimes popularly misunderstood), nor that insecticides must be only a minor part of any IPM control strategy, nor that insecticides are only the last option or choice of last resort in some type of mitigation hierarchy aimed at curtailing insecticide use, nor that in the choice of what mosquito control insecticides to possibly use that larvicides always have to come first, adulticides second. Rather IPM refers to making the best use of a combination of the most practicable control methods at one's disposal to deal with real world situations in treating specific types of pest problems only when and where they occur, doing such in the most efficacious, environmentally-compatible, cost-effective manner possible. As such depending upon the pest problem at hand or being confronted, pesticide use can be and often is an important, integral part of employing IPM, and in many cases can be the major component of an IPM program. And while in many cases practice of IPM can indeed decrease the need for pesticide use, this isn't always the outcome here nor has to be, given the particulars for whatever type of pest problem is being addressed.

Because of the diversity of aquatic habitats in Delaware where mosquitoes breed, and because of their varied life history stages, times of occurrence and behaviors, on a statewide basis the Mosquito Control Section must use a mixture of control methods in customized manner, hence our adoption of an IPM control strategy. Our IPM approach primarily involves encouraging the public to practice good water sanitation on their properties, urging the public to take personal protection measure to avoid or reduce mosquito bites, and the Section using source reduction techniques (e.g. water management, habitat modifications, fish stocking) along with the judicious applications of several types of insecticides, with the latter falling into two broad categories -- larvicides to control immature mosquitoes in their aquatic stages, and adulticides to control adult mosquito populations. All of this constitutes IPM for mosquito control as practiced by the Mosquito Control Section.

Purpose of EPA's New Type of NPDES Permit, Relative to IPM

It should first noted that in accordance with what many U.S. Environmental Protection Agency (EPA) staff have acknowledged during development of EPA's Pesticide General Permit (PGP) for aquatic pesticide use, the purpose of this new type of NPDES (National Pollution Discharge Elimination System) Permit is ***not*** to limit or minimize the use of aquatic pesticides, but rather to try to ensure that whatever is applied is done in accordance with only using the amounts of pesticides that are needed to satisfactorily achieve or accomplish pest management goals, and to thereby then avoid any overuse of these products; and to also help ensure that such pesticide use is also done as safely as practicable in terms of avoiding or minimizing any possible corollary adverse impacts to non-target organisms or the environment. These are also the goals of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) that has seemingly quite adequately regulated pesticide use for over 40 years, whereby FIFRA is the foundation for EPA's highly successful pesticide product registration and regulation process within EPA's Office of Pesticide Programs (EPA/OPP).

When aquatic pesticides are applied to water, or over or near water, they are used for beneficial purposes often associated with meeting or addressing important socio-economic needs (e.g. food production, timber or fiber production, control of invasive plants or nuisance animal species) or with protecting public health (e.g. mosquito control, noxious algae control), and thus are products developed and used for the public good, whose use should ***not*** be unduly restricted, especially since the consequences of any undue restriction could be quite severe in myriad ways. It's only after these pest control products have achieved or accomplished their intended beneficial purposes might their possible residues (whatever such might be) then possibly be viewed as being some type of "pollutant" or "contaminant," especially if they might become long-lasting residues or product degradates possibly having substantial adverse impacts to non-target organisms or the environment. EPA's traditional approach to addressing many water quality issues that relies heavily upon "minimizing discharges of pollutants to waters of the U.S.", which is of course a most worthy goal in many instances achieved via NPDES permitting programs (with historical focus on controlling end-of-the-pipeline industrial discharges or wastewater outflows), unfortunately really isn't a great fit in dealing with beneficial use products that are applied to waters on an as needed basis and in amounts needed for societal good, yet then in some rare cases might become problematic inputs after their benefits are achieved. Since the use of mosquitocides must remain a very important, integral component for an overall strategy in conducting mosquito control, it's important that such use occur in a broader IPM context.

Monitoring

Post-spray monitoring to examine the control efficacy of pesticide use is an important part of IPM, and something that the Mosquito Control Section undertakes as warranted and feasible and as our operational resources allow. We have a long history of using our mosquitocide products in effective and safe manner, and via many sources -- e.g. EPA, our laboratory tests, experiences and findings of product manufacturers or other mosquito control programs, our direct field observations -- we have high confidence in the control efficacy of our chosen products, and also the almost total lack of their possibly causing any type of gross mortalities or other significant impacts for non-target organisms (or their habitats or the environment). The latter lack of detrimental impacts or adverse incidents is primarily attributable to FIFRA and EPA's product registration process and product label use directives, which allows EPA to be able to scientifically say that use of EPA-registered products when applied in correct manner "poses on unreasonable risks to human health, wildlife or the environment."

While in accordance with EPA's PGP, the PDMP does not have to contain any type of visual monitoring plan or schedule, for the record we systematically make visual observations in representative manner of any possible observable detrimental impacts or adverse incidents possibly caused by our mosquitocide use whenever we undertake our control efficacy back-checks in the field, and we'll continue to do such in fulfilling a PGP requirement. The very few times over the past >30 years when an adverse incident was observed in the field either at or nearby where or when a mosquitocide was applied have all turned out to be attributable to causes other than mosquitocide spraying, with mosquitocide use having nothing whatsoever to do with such observations (e.g. a fish kill ended-up attributable to low dissolved oxygen concentrations in the water caused by a host of other factors, or a shorebird mortality event ended-up attributable to botulism poisoning from natural causes). Observational monitoring requirements that are part of EPA's PGP for matters such as amount of pesticide used (which must first-and-foremost also be done in accordance with FIFRA), or for calibration, maintenance or repair of spray equipment, or for spill prevention measures, are covered in Section IV-A of this PDMP.

B. No Action

Given the expansiveness, types and intensities of mosquito problems occurring in Delaware, taking no action to control mosquitoes is totally unacceptable (see Sections II-A and II-B of this PDMP for an overview of these problems). Delaware's myriad mosquito production habitats and environments, combined with our temperate climate, cause mosquito populations to be a severe scourge and major plague if unabated.

Delawareans expect and demand relief from this situation, and have voted both with their will and their pocketbooks to see that mosquito populations are at least kept at tolerable levels. Just as modern-day society now expects adequate food supply, affordable housing, and convenient transportation, there's also an expectation relative to mosquitoes for a relatively pest-free and disease-free environment (unlike what use to occur in Delaware prior to the 1950s, before more modern approaches to mosquito control where adopted).

Delaware is in the Top 10 states in the country for percent wetlands cover, and in the Top 10 states in the country for human population density too, being an unholy combination that makes for many mosquito control problems and challenges. With some problematic species of mosquitoes (e.g. the common saltmarsh mosquito) being able to routinely fly 3-5 miles away from their natal marshes, and at times and in some locations even 15-20 miles away, mosquitoes can truly cause widespread problems in a state as small as Delaware.

Organized professional mosquito control has existed in Delaware for almost 80 years, dating back to 1933 as a statewide, state agency function. The people of Delaware have clearly spoken that these mosquito problems must be kept in check; and the Delaware General Assembly has mandated that mosquito infestations be prevented or controlled, per Delaware Code Title 16, Chapter 19 (see Section II-B of this PDMP), which in turn charges DNREC Division of Fish and Wildlife's Mosquito Control Section to meet this need.

Viewing the No Control pest management option in a more technical light and provincial manner, and in also being a matter that'll be discussed in more detail in other sections of this PDMP, it should be noted that in almost no cases or situations regarding possible insecticide use will control actions be taken if Spray Threshold Criteria have not been exceeded (see Section II-D of this PDMP). For example, no action might be taken when sites containing mosquito larvae are known to be excessively shallow, and extended weather forecasts then indicate dry conditions. Such situations can allow larval habitats to dry-out before mosquitoes can complete their aquatic life stages, and hence no adults result.

C. Prevention

It's really not feasible or practicable to prevent or stop all mosquito production, although there are measures that can be taken to eliminate or reduce some types of mosquito egg-laying (oviposition) sites, or to eliminate or reduce some types of mosquito larval-rearing habitats, and to do such without reliance upon insecticide products. The Mosquito Control Section prefers wherever practicable to use non-insecticidal control methods, since the exceedingly small risks that might be associated with mosquito control spraying obviously go to zero if or where no spraying is done. The most practicable alternatives to using insecticides are a category of control methods collectively called source reduction, which through various approaches either eliminate mosquito-producing habitats, or somehow control mosquitoes in their pre-emergence larval stages.

Practice Good Water Sanitation

Many adult mosquitoes around the home often come from mosquito-production sites within the neighborhood or in close proximity to residential areas. To help minimize mosquito annoyances, homeowners should take steps to eliminate or reduce standing or stagnant water on or nearby their properties, including attending to potential mosquito-production habitats such as clogged rain gutters and downspouts, water remaining in corrugated downspout extenders, poorly-drained flat roofs, old tires, abandoned in-ground or aboveground swimming pools (including plastic kiddie wading pools), unused bird baths, depressions in boat cover-tarps, bilge water in boat bottoms, flower pot bottom liners, garbage cans or their upturned lids, discarded soda or paint cans, upright wheelbarrows, or any other types of structures or containers that can collect and hold water for 4 or more consecutive days. [Just imagine the numbers of nooks-and-crannies that might hold rainwater in an auto salvage yard or a scrap tire pile.] In addition, any grading of topsoil for grass planting or following septic system installation should ensure that rain or sprinkler-system water does not become puddled or trapped on the surface for any extended length of time. Ornamental ponds can also breed mosquitoes, and since one obviously wants water here, other control measures might have to be taken – e.g. ensuring good flow or changeover of water to avoid stagnant conditions, stocking or raising fishes that eat mosquito larvae, or judicious treatment with an appropriate mosquito larvicide. Property owners practicing good water sanitation around their homes or businesses can measurably help to reduce mosquito-production habitats. Public education and cooperation is the key to this type of domestic water sanitation source reduction. The Mosquito Control Section brings to bear whatever resources we have at our disposal in a public information and education campaign for property owners to adopt these types of mosquito prevention measures. Unfortunately in our experience, the vast majority of people will fail in either doing or being disciplined enough to consistently practice good water sanitation, such that solely relying upon this approach will often not result in acceptably low mosquito populations in many urban, suburban or exurban areas.

Take Personal Protection Measures

There are also many types of personal protection measures (PPM) that an individual can take to prevent or help reduce mosquito bites, and through an aggressive public information and education effort within limits of our working resources, the Mosquito Control Section promotes use of such measures. Probably the simplest action whenever possible is to try to avoid areas where mosquitoes are most active, such as near coastal marshes, wet woodlands or other swampy locations.

If you happen to live in a mosquito-prone area or have occasion to visit such, then your next line of defense is try to stay indoors if possible during times of peak mosquito activity, which for many species is near dusk, during the evening or night, and into early morning. Using and keeping your door and window screens in good repair is an obvious measure. [In many areas, folks who are fortunate enough to have screened-in porches are very grateful they do.] Wherever mosquitoes might still be a problem inside a residence, the old practice of using mosquito bed-netting could be resurrected. However, some particularly troublesome species, such as the common saltmarsh mosquito or the Asian tiger mosquito, are also very active daytime biters -- since many people must be outside and active during the day, the avoidance measures above don’t have much applicability.

The type of clothing one wears can also help to reduce mosquito bites. If it's not too hot or uncomfortable, consider wearing long-sleeve shirts and pants when outside. There are many modern synthetic, breathable, light-weight fabrics which make this option more feasible than ever before. Wearing light-colored clothing also helps (in particular, avoid red colors). If the mosquito infestation is truly bad and you must remain outside, one might want to consider using a fine-mesh head net, or a mesh "shoo-bug" or "bugout" jacket treated or untreated with a repellent. Using yellow light bulbs for outside lighting might also help.

Avoiding outside activities that require a lot of exertion and hence generate a lot of carbon dioxide, a powerful natural mosquito attractant, is also advisable in mosquito-infested areas. Physical exertion also produces body heat and lactic acid in sweat, which are also attractants for mosquitoes. Also do not use strong-smelling perfumes or cologne, nor fragrant soaps, shampoos or hairsprays.

Probably the most common remedy for contending with having to work, live or recreate outdoors in mosquito-infested areas is the use of some type of chemical repellent. Scientific studies have shown that by far the most effective types of repellents are commercially-available, over-the-counter products that contain the chemical DEET (e.g. OFF, Cutter, Muskol, Ben's, 6-12, Sawyer). Other types of repellents are also available, including certain brands of cosmetic creams that might have some repellent effect (e.g. Avon Skin-So-Soft), or various "natural" oils, spices or other extracts (e.g. eucalyptus oil, lemongrass, pennyroyal, allspice, bay, camphor, cinnamon, citronella, garlic, geranium, lavender, nutmeg, peppermint, pine, thyme). However, scientific evidence shows most of these alternative products to be of comparatively little or only marginal effectiveness – nonetheless, the bottom line here is to use whatever one thinks or "knows" works best .

There is a very small percentage of people who might have some adverse health reactions to high concentrations of DEET (e.g. 50-100%), so as a general rule it's recommended that adults use repellents containing a DEET concentration of 30% or less, and for children the concentration should be 10% or less. Do not use DEET on infants under 2 years old. From the standpoint of health precautions, it's better to more frequently apply formulations with lower DEET concentrations, versus infrequently applying formulations with higher DEET concentrations. Be sure to follow all application instructions on a repellent's label. If one wants to avoid using DEET-based repellents all together, the EPA has recently determined that two other products also provide some effective relief – picaridin and oil of lemon eucalyptus.

Another type of chemical defense is to spray clothing with permethrin, a synthetic pyrethroid (e.g. Permanone), which actually functions as both an insecticide and a repellent, and is also used to help prevent tick problems. If permethrin is used, it should be applied only to clothing and never directly to skin, and all instructions for use must be closely followed.

Clip-on, hand-held, or coil/lantern type devices (e.g. Thermacell, OFF! Clip-On, OFF! Mosquito Coil, etc.) have recently come to market that operate by either heating an insecticide impregnated pad or otherwise blowing a repellent, which in turn at least in theory creates a mosquito-free zone immediately around the wearers of such devices.

Other Prevention Measures

There are other measures that one can take around home or property to prevent or reduce mosquito bites, but the true effectiveness of these latter methods is quite dubious relative to the level of relief needed or sought. Some people find that burning certain materials (e.g. citronella candles, sticks or coils) to be of some limited help in keeping mosquitoes away from their personal airspace. It is known that Native Americans tried such smoky approaches (e.g. “smudge pots”) to achieve some mosquito relief (if they could stand the smoke and smell), but during seasons of peak mosquito activity some Indian tribes were also in the smart habit of relocating their villages to less mosquito-prone sites.

The electronic “bug zappers” that are so popular in some neighborhoods have been scientifically shown to really be of very little value in controlling mosquito populations, and have also been documented to have adverse impacts on non-target insect species. Commercial mosquito collection/killing traps (e.g. Mosquito Magnet, Mosquito Deleto), some which are rather sophisticated with lights, fans and sources of carbon dioxide or other attractants (e.g. octenol), might be marginally effective in some localized situations. However, because of their relatively high expense (several hundred dollars per unit) and limited areal effect (supposedly about ½-acre), these devices are really not very effective for contending with larger-scale problems, and hence not very practicable to consider using for large-scale needs or operations. But this is not to say that these devices cannot provide some very localized relief in your backyard setting, if not in terms of a noticeable drop in the numbers of mosquitoes that are biting you, then perhaps at least for psychological relief, in that you’re at least doing something to help kill some mosquitoes.

The Mosquito Control Section as part of the Delaware Division of Fish and Wildlife (DFW) also interacts with DFW Fisheries and Wildlife staff relative to water management practices in the State’s coastal impoundments, and encourages impoundment water management practices that will prevent or help avoid mosquito production from occurring within these impounded units, to then be considered and implemented to the extent practicable without undue adverse impacts to other impoundment management goals. The Mosquito Control Section also urges the U.S. Fish and Wildlife Service (USFWS) to consider and adopt similar mosquito prevention water management practices for the Service’s management of its coastal impoundments, and for any moist soil management units, at Bombay Hook and Prime Hook NWRs.

D. Mechanical/Physical Controls

Open Marsh Water Management (OMWM)

Mechanical/physical controls relative to mosquito control primarily involve various types of water management methods or practices implemented for source reduction purposes. Because of the long flight ranges of saltmarsh mosquitoes and the remote wetland areas where these mosquitoes are often produced, the Mosquito Control Section devotes a lot of its efforts to managing saltmarsh habitats for reduction of mosquito production, including using a source reduction technique known as Open Marsh Water Management (OMWM). The OMWM method selectively excavates small, shallow ponds and ditches in mosquito-production areas of the high salt marsh, which in doing helps eliminate or reduces egg-deposition habitats for saltmarsh mosquito species (which require moist muds for their egg-laying), and which then also provides permanent water habitats for resident native fishes (e.g. killifishes, *Fundulus*) that are voracious predators upon mosquito larvae. All OMWM wetland alterations are done under a Section 404 statewide OMWM permit issued by the Army Corps of Engineers, and are done under regulatory oversight by the Delaware Mosquito Control Advisory Committee (DMCAC), consisting of four federal agencies (Army Corps of Engineers, U.S. Environmental Protection, U.S. Fish and Wildlife Service, National Marine Fisheries Service), four DNREC agencies (Division of Fish and Wildlife including Natural Heritage Program staff, the Division of Water's Wetlands and Subaqueous Lands Section, the Delaware Coastal Management Program, and the Division of Parks and Recreation's historical/cultural affairs program), and the State Historic Preservation Office.

Most OMWM alterations are not directly connected to daily tidal flows, such that OMWM ponds and ditches do not typically drain or dewater marsh surfaces of their standing water bodies, nor excessively lower the marsh subsurface water table. This helps to control saltmarsh mosquitoes without insecticides in a manner that avoids the previously detrimental ecological impacts of the old parallel-grid-ditch system, which were open tidal ditches geometrically spaced about 150-feet apart, traversing much of Delaware's tidal wetlands (in both mosquito-production and non-production areas), with intention to drain or dewater marsh surfaces. The parallel-grid-ditches were constructed by the Civilian Conservation Corps in the 1930's, and these ditches were periodically recleaned of accumulated sediments into the 1970's. The open, tidal parallel-grid-ditches had adverse impacts on saltmarsh habitats by draining many shallow ponds and mudflat areas that were valuable fish and wildlife habitats, and in some areas through spoil deposition (from the ditch excavations), or by lowering of the subsurface water table by low tide drainage, caused undesirable vegetation changes (e.g. incursions of marsh shrubs such as *Iva* or *Baccharis,* or the reed grass *Phragmites*, in ditched areas). Furthermore, while the old parallel-grid-ditches helped to reduce mosquito production in some areas, these ditches were still not effective enough to achieve the desired level of control needed in many locations, because mosquito-production habitats between the parallel-grid-ditches (particularly the small "pothole" depressions) were not drained.

Today's modern OMWM technique avoids these problems by using specialized excavation machinery that does not cause excessive increases in marsh elevations from spoil deposition (e.g. an amphibious, low surface pressure rotary excavator, which broadcasts excavated spoil as a thin slurry over the marsh surface); by OMWM system design and excavated alterations that do not lead to excessive lowering of the subsurface water table; and by actually satisfactorily controlling almost all mosquito production in areas that are treated. Furthermore, the installation of OMWM systems as overlays upon old parallel-grid-ditch networks helps to restore standing surface waters to the marsh valuable as fish and wildlife habitats, thereby restoring some lost wetland values and functions. Unfortunately, OMWM cannot be used everywhere saltmarsh mosquitoes breed, because of factors like not having marsh landowner permission or cooperation (for a variety of reasons); by site access considerations for heavy marsh machinery; by other environmental considerations (e.g. leaving intact the relatively little salt marsh acreage in Delaware, and within the entire Northeast too, that still remains undisturbed by any type of visible alteration, such as what is found at Bombay Hook National Wildlife Refuge); or by project size or project scale (it's not usually cost-effective to treat small marsh areas or small amounts of mosquito production with OMWM, especially when there are so many larger areas of the state's coastal wetlands still needing OMWM treatment). Wherever there are problematic salt marsh habitats that cannot be treated with OMWM, then judicious use of insecticides must be employed; and because of the scale of the problems encountered in salt marshes, usually treated via aerial spraying by fixed-wing aircraft, or sometimes if more localized treated via helicopter. Installing OMWM systems is a labor- and capital-intensive undertaking, but in the long-run is usually more cost-effective than continual periodic treatments with insecticides.

Within Delaware's approximate 95,000 acres of tidal wetlands, about 15,000 acres around the state were originally targeted back in the early 1980s as warranting OMWM treatment, but due to landowner access issues (particularly at Bombay Hook NWR due to USFWS land management policies), this target acreage was scaled back to 9000 acres. To date the Mosquito Control Section has successfully treated with OMWM about 7000 of these targeted 9000 acres (including several hundred acres at Prime Hook NWR), with our continuing to slowly work on the remaining 2000 acres as landowner access and operational resources allow. Wherever OMWM work has been performed to date, the need for any larviciding has been significantly reduced.

Coastal Impoundment Management

Other types of source reduction practiced by the Mosquito Control Section include management of tidal flows or exchanges and marsh water levels to discourage or control mosquito production in coastal wetlands impoundments, which on federal, state and private lands total over 10,000 acres of Delaware's approximate 95,000 acres of coastal wetlands. These impoundments are areas of marsh that are diked-off with levees, whose interior waters are then managed by various types of water control structures for multiple environmental goals and objectives, including flood prevention, stormwater management, waterfowl production and hunting, habitats for wading birds and shorebirds, estuarine fish nursery areas, crabbing and fishing, saltmarsh mosquito control, nature study, canoeing, etc.   Along with other colleagues in DNREC's Division of Fish and Wildlife, the Mosquito Control Section plays a major role on State lands in helping to maintain and manage these valuable wetland units.

It is not always possible (nor desirable) to manage tidal exchanges or marsh water levels in impoundments for only one purpose, so sometimes it's not always possible to achieve satisfactory mosquito control in impoundments through water management alone, which might then necessitate some judicious insecticide spraying (using larvicides), usually with a helicopter, but sometimes in more expansive impoundments by fixed-wing aircraft.   Shallow ponds and ditches can also be excavated within impoundment interiors to help control mosquito production, but these features are often difficult to maintain because of the unconsolidated nature of many impoundment bottoms, which then tend to rapidly fill-in any excavations that were made, routinely requiring re-excavations.   However, where still cost-effective to routinely do this periodic re-excavation, and in order to reduce insecticide use or maintain or enhance fish and wildlife habitats, the Mosquito Control Section is committed to undertaking this impoundment source reduction work.

Other Mechanical/Physical Controls

A type of physical manipulation that occasionally is done on a localized basis is selective removal of blockages in drainage ditches that if not removed create mosquito larval-rearing habitats upstream of the blockages, or that serve as barriers to natural predators of mosquitoes. Such drainage ditches can be in freshwater or upland areas, or in tidal wetlands. But any such blockage removals are designed and implemented with due consideration for other factors, including trying to minimize any adverse corollary environmental impacts. At times such blockage removals might involve beaver dams, but only when there are perhaps other more pressing needs for beaver dam removals, typically involving the need to alleviate flooding problems for upstream infrastructure or land use. And it should also be noted that due to environmental considerations and concerns, the Mosquito Control Section for the past 35 years is no longer in the business of routinely re-cleaning the old parallel-grid-ditch network in salt marshes.

One of the newer and more novel physical controls is trying to use ultrasonic sound waves to physically kill larvae by rupturing air pockets or bladders within their bodies, which shows some promise in smaller or tightly confined aquatic habitats (e.g. Larvasonic for treating storm sewer catch-basins), but awaits further research in terms of control efficacy, non-target impacts, and practicable utility.

E. Cultural Methods

Cultural methods for mosquito control is a categorization that can encompass a wide range of control measures. Some people might consider the education (enculturation) of people to practice good water sanitation on their properties, or to take personal protection measures to avoid or reduce mosquito bites, as being cultural methods, which were discussed in Section III-C of this PDMP. Reduction of mosquito larval-rearing habitats in stormwater management basins or ornamental ponds via aquatic vegetation management practices might also be considered a cultural method of control. Another type of cultural method might involve asking residents or visitors to be more tolerant of whatever mosquito bites they might experience (e.g. simply try to ignore them), but this approach would have only checkered success at best given individual tolerances for such injuries, varying from a farmer who's been tilling a field adjacent to a salt marsh for over 30 years and who won't get off his tractor even when mosquitoes might be swarming about in numbers where he's inhaling them, to a newly arrived resident in Delaware or a seasonal tourist where receiving even one mosquito bite is one bite too many. And given the theoretical risk for transmission of mosquito-borne diseases even from one bite, asking people to simply be tolerant of any bites they receive wouldn't be good public health practice.

We will not dwell here on cultural methods in a separate Section III-E, since these types of control methods are addressed in various manner in Section III-B (Prevention), Section III-C (Mechanical/Physical Controls), and in Section III-F (Biological Control Agents) of this PDMP.

F. Biological Control Agents

Stocking Larvivorous Fish

The heavy reliance upon marsh killifishes (*Fundulus* spp.) as an integral component of the Open Marsh Water Management (OMWM) source reduction method discussed in Section III-D of this PDMP makes mention of an important biological control agent for mosquito control in Delaware. Another type of source reduction relying upon biological control agents performed by the Mosquito Control Section involves the stocking of native mosquitofish (*Gambusia holbrooki*) in freshwater mosquito-production habitats, such as in stormwater management basins that are often associated with subdivision developments or highway projects, or in small natural or ornamental ponds. Unfortunately, mosquitofish survival cannot always be ensured in many of these locations, because of water volume or water quality problems, and often because of too cold overwintering temperatures, eliminating the stocked fish. The rearing and distribution of mosquitofish is also very labor intensive. Additionally, stocking mosquitofish in some natural areas cannot be done because of concerns about adverse impacts to other native fishes through interspecific competition, or because of concerns about predatory impacts upon amphibians of special concern. Unfortunately, there is not a freshwater "OMWM-equivalent" source reduction method for dealing with non-tidal mosquito production problems found in freshwater wetlands or wet woodlands. When source reduction using mosquitofish cannot be employed, then these types of habitats must be treated with insecticides (primarily larvicides), often done by hand or ground-application equipment. Finally, in regard to source reduction approaches for stormwater management basins, there are considerations in a basin's design and construction, and in management of its water levels or vegetation, that will help to reduce mosquito production, all which are encouraged by the Mosquito Control Section to be followed by developers or other agencies, and as such are more along the lines of mechanical/physical controls or cultural methods.

Birds and Bats

Other types of source reduction involving biological control agents are possible, but unfortunately their overall effectiveness is usually not satisfactory, or is often not up to what one is sometimes led to believe will occur. For example, encouraging on one's property through nesting structures colonies of purple martins (via elevated, multi-chambered "martin houses") certainly cannot hurt, but scientific studies have shown that when mosquito production is even moderately high, and the production problem emanates from expansive nearby areas, that these birds are really not very effective at all in reducing mosquito infestations, even for achieving the local relief that might be desired. Part of the problem stems from purple martins actively flying and feeding during daytime only, whereas many mosquito problems are most pronounced during twilight periods or dark (the birds might have more of a beneficial effect here via controlling daytime biting greenhead flies, deer flies, and perhaps some biting gnats), along with their preference for prey items typically larger than mosquitoes.

If one is looking to encourage airborne predators to help combat local mosquito problems, building bat houses to encourage colonization by nocturnal flying bats is probably more effective; but then one also has to enjoy or at least tolerate having bats around, which aesthetically some people (especially neighbors) might not like, not to mention concerns about bats carrying and possibly transmitting rabies; along with the fact that outside of confined and contrived laboratory conditions, the diets of bats in the wild don't show a preponderance for mosquito prey, and in fact the mosquito portion of any bat's diet is often marginal at best.

Sole reliance upon purple martins, bats or other aerial predators, including dragonflies too, to deliver in the real world the level of mosquito control needed, expected and demanded by modern society would be considerable folly, although whatever these aerial predators might do to help lower mosquito populations is certainly welcomed and to the good. For many locations and since time immemorial, eruptive mosquito populations have evolved to simply outstrip or outrun any-and-all natural predators' ability to satisfactorily control them, which in large measure is why mosquitoes are so successful at being the scourges they are.

Other Types of Biological Control Agents

The mosquito larvicides *Bacillus thuringiensis* var. *israelensis* (Bti) and *Bacillus sphaericus* (Bs) are at times considered types of biological control agents due to their source and derivation, as is methoprene larvicide too due to its mode of action in being a "bio-rational" product involving a juvenile growth hormone, but discussion of these control tools will occur in Section III-G (Pesticides) of this PDMP.

It should be noted that the mosquito control profession is always on the lookout for more efficacious, cost-effective control methods that also lessen any non-target impacts, with some novel approaches often involving biological control agents. Various alternatives have been proposed or arisen, and many have been tested, such as introduction in the field of irradiated, sterilized adult male mosquitoes or genetically manipulated mosquitoes to try to lessen reproductive potential; the introduction of fungi, protozoans, nematodes or other microbial pathogens to infect and kill mosquito larvae; the introduction of mosquito species that as larvae prey upon other mosquito larvae ("cannibal" mosquitoes), or the introduction of predatory copepods; etc. However, while these alternatives might look good in theory or in the lab, in terms of their performance in the field, or in regard to their practicability for large-scale operations, they have so far not been satisfactory. In collaboration with academic researchers and product manufacturers, we are always seeking "new chemistries" or other improved technologies for potential adoption for our control toolbox (e.g. insect growth regulators, ovipositioning repellents, algal- or plant-produced toxins, population autoinhibitors, molecular or DNA-based insecticides), perhaps leading to yet another generation of further improved insecticides.

G. Pesticides (mosquito control insecticides)

EPA-registered Mosquitocides and Their Safety

The Mosquito Control Section only uses insecticides that are registered by the U.S. Environmental Protection Agency (EPA) for mosquito control purposes. The EPA has determined through an inclusive and exhaustive science-based testing and review process under FIFRA that when these modern insecticides are applied in accordance with all EPA-approved product label instructions, which by federal law must be followed, their application "poses no unreasonable risks to human health, wildlife or the environment." The EPA's review process now typically entails that a pesticide manufacturer must spend almost 10 years and from $30-$50 million dollars, and sometimes up to $100 million, in testing before being allowed to bring a new product to market, and also has to invest significant resources in keeping an existing pesticide re-registered for continued use, all which is given careful scrutiny and review by EPA. In part, the types of testing done include exposures and reactions of birds and mammals to ingested, inhaled or dermal contacts with a pesticide; as well as examining acutely toxic and sub-lethal chronic effects of pesticide exposures to fishes, reptiles and amphibians, and to terrestrial and aquatic invertebrates (with various types of tests done on adults, juveniles, and larval or other immature forms).

The hazardous warning statements and other safety precautions that appear on pesticide product labels are often a source of concern to folks who do not understand their context or applicability, and as such sometimes present public relations problems for our program. It must be kept in mind that the EPA-approved warning or precautionary language on product labels is targeted primarily toward avoiding a human or other type of organism from having direct exposure (through ingestion, inhalation or dermal contact) to full-strength, undiluted products, as well as what to do if such exposure has somehow occurred. The product label language is also of primary utility to the spray applicators themselves, who most frequently might routinely or accidentally have such exposures. It must be understood that the final application of insecticides during our routine spray operations is always done via a mode of delivery approved by the EPA, with applications made at concentrations that are either always very diluted or at Ultra-Low Volume (ULV) rates, and which are not done very frequently for any given site. As such in real world use, these application conditions have allowed the EPA to scientifically conclude that when all product label language and instructions are followed as federal law requires, use of our mosquito control insecticides “poses no unreasonable risks to human health, wildlife or the environment.”

As part of the Delaware Department of Natural Resource and Environmental Control (DNREC) within the Division of Fish and Wildlife, the Mosquito Control Section is of course very concerned that there are no unacceptable non-target impacts (to humans or fish and wildlife) whenever we must conduct our spray operations. The first generation of more modern insecticides arose in the 1940’s, which included long-lasting products like chlorinated hydrocarbons (e.g. DDT), whose environmental persistence unforeseeably might have led to some problems for some higher-order consumers, and which has now been replaced by much shorter-lived second and third generation modern insecticides that are much more “environmentally friendly.” As such, we do not anticipate or feel that it’s very likely, as history as shown us to date in our applying EPA-registered mosquitocides in Delaware for many decades, that we’re going to experience any substantial problems along these lines. The EPA has been hard at work ever since the early 1970s to improve the environmental compatibility of all types of pesticides, including mosquitocides, and today’s modern array of EPA-registered products attests to the Agency’s success. In regard to the mosquitocide products used by the Mosquito Control Section, particularly over the past 30 years or so, our frequent use of these products around the state has, in regard to any human discomfort or ills upon exposure to these products, been exceeding rare, as has any reports of such effects for pets or other domestic animals; and any reports or observations of adverse impacts to other non-target organisms or to the environment possibly stemming from our mosquitocide use have also been exceedingly rare. The outcome of EPA’s rigorous, science-based product registration process, whereby our modern mosquitocide products can be used with a high degree of confidence in their safety, seems to have been well validated by how often and how widely we’ve used these products for decades with very little if any adverse consequences.

Nonetheless, this is not to say that all concerns about the potential for yet unknown or poorly-understood non-target impacts, even when products are used in strict accordance under FIFRA with all EPA-approved label instructions, have completely faded for all modern insecticides – e.g. in the last several years concerns have arisen about potential endocrine system effects (“endocrine disrupters”) associated with certain types of pesticides (or with their accompanying synergists or other additive ingredients), which probably bears objective tracking and further scientific inquiry, or what might be the roles if any for a product’s inert ingredients relative to any possible adverse impacts. However, it is fairly safe to say that the benefits of judiciously using modern-day pesticides to help meet important societal needs (e.g. for mosquito control, rodent control, disease prevention, crop production, food storage, timber production, structural building protection, landscaping needs, etc.) far outweigh any known risks for EPA-registered products, since the EPA's scientific product registration or re-registration process over the past 40 years has taken almost all previously-used "bad actor" pesticides off the market, and has not knowingly let any new "bad actor" products into the market.

As such, in today's era of heightened environmental awareness, almost all remaining potential problems for human health or non-target organism impacts caused by mosquito control spraying might primarily arise from human mistakes or application errors that might be made in the rate of application (e.g. spray equipment calibration errors), the timing or place of application (e.g. accidentally repetitively swathing the same area), or with other operational aspects of performing spraying (e.g. spraying when too windy or not windy enough), all which can be readily avoided when product label instructions are scrupulously followed, and applications are made by dedicated, trained professionals. Mosquito Control Section staff and our contractual spray pilots are all knowledgeable professionals certified by the Delaware Department of Agriculture for using insecticides in proper and safe manner.

Use of Larvicides and Adulticides

There are two basic types of mosquito control insecticides – larvicides for control of larval or immature mosquitoes, selectively applied to wetland areas and other aquatic larval habitats; and adulticides for control of flying or resting adults, selectively used primarily in upland areas where adults on-wing are causing problems. All insecticides that we use are registered by the U.S. Environmental Protection Agency (EPA) for the types of applications we perform. Insecticide applications are done only when and where we have indications of unacceptable or intolerable numbers of mosquitoes either undergoing larval development or already on-wing, and these mosquitoes must also be of the 19 or so species that are particularly problematic biters of humans or other mammals. Indications of when and where spraying is necessary are derived through an extensive and intensive field surveillance-and-monitoring effort, involving a variety of detection efforts as described in Section II-D of this PDMP – e.g. larval sampling in wetlands and other mosquito-production areas ("dipper counts"); landing rate counts (i.e. numbers of adult female mosquitoes that land on a field inspector per minute); nightly adult light trap collections; detection or occurrence of disease viruses or other pathogens within mosquitoes themselves or in sentinel organisms; the numbers and patterns of public complaints received; etc. No spraying is done unless threshold criteria (involving subjective or objective measures) are exceeded for these various indicators, and quite often a combination of indicators is used.

Spray applications might be aerially done using fixed-wing aircraft or helicopters for larvicides or adulticides, or might involve truck-mounted applications of larvicides (e.g. via "pump truck" for treating roadside ditches) or adulticides (via "foggers" for treating cities, towns, subdivisions or strip developments). Larviciding to treat small areas or container habitats is often done on-foot, using backpack sprayers or hand-tossed formulations. The choice of what type of insecticide to use and its mode of delivery is dependent upon the type of species to be controlled, the life stage(s) targeted for control during any particular brood, and the type of habitat or location where spraying will occur.

Larviciding vs. Adulticiding

Since in almost all cases larviciding involves less direct exposure of people to insecticides than adulticiding, and at times also less area to treat, whenever we have to spray in an IPM context, we usually prefer to try to larvicide first, and typically then turn to adulticiding essentially as a secondary resort. Many larvicide products are also more target-specific than adulticides, having less potential for non-target organism impacts, so from an environmental standpoint there can also be a preference for larvicide use over adulticide use. However, given a particular setting or circumstance and still much in keeping with IPM practices, adulticiding might become our first spray choice, and in our having to practicably deal with many types of realities, we still perform a lot of adulticide spraying. And whether we're using EPA-registered larvicides or adulticides, EPA has scientifically determined that when applied in accordance with all product label requirements, their use poses "no unreasonable risks to human health, wildlife or the environment." But nonetheless, to address any given mosquito production situation where it'll be practicable, efficacious and cost-effective to use larvicides instead of adulticides, then we have a preference for larvicide use.

Now here are some examples where adulticiding might be the preferred treatment option, either as a stand-alone method or in conjunction with larvicide spraying too. If a widespread flooding or inundation event takes place (e.g. in the aftermath of a hurricane or major storm), it might be more economical and environmental friendly to allow mosquito larvae to emerge and then treat for adults at a later time if and where necessary. This is because not all larval habitats might be able to be treated in a timely manner to prevent adult emergence; or the amount of acreage that would have to be larvicided might too large to practicably treat (thereby not being what you would want to treat due to pervasive or extensive environmental considerations, or as presenting some significant budgetary problems); or problematic numbers of adult mosquitoes might migrate into an area that was previously larvicided, coming from surrounding regions that for one reason or another weren't able to be larvicided. One must realize that not all or even a large amount of larval-rearing habitats can be treated via larviciding, with the types or extents of larval habitats and physical access to such habitats often being determinant factors for larviciding feasibility. For example, many mosquito control programs in south Florida cities or towns can't practicably contend with their local mosquito production problems via larviciding huge areas of expansive, nearby mosquito-producing marshlands, but instead more surgically have to rely upon adulticiding relative small areas along city or town borders as marsh-produced adult mosquitoes invade populated areas. While in a perfect world one might desire to undertake all mosquito control insecticide treatments via larviciding, unfortunately in the real world this simply can't be.

Some examples for this situation arise when the Mosquito Control Section is working on Delaware's two National Wildlife Refuges, but also occur in other areas of the state too. In our contending with saltmarsh mosquitoes produced on Prime Hook NWR, for environmental and economic reasons it's typically preferable (in conjunction with some timely, judicious larviciding of refuge marsh) to only have to infrequently aerially adulticide (up to 6 times per year) over a few hundred acres within or nearby the 3 bayfront communities of Slaughter Beach, Primehook Beach, and Broadkill Beach (including adulticiding over a narrow, 600-ft wide marsh-upland strip of federal NWR lands behind these 3 bayfront communities, amounting to about 227 acres or only about 2.3% of the refuge's total area, that at times serves as harborage for massive amounts of refuge-produced adult mosquitoes) than to have to more frequently larvicide over thousands of acres of nearby refuge marsh. Similarly for a situation at Bombay Hook NWR involving a strip of marsh-upland ecotone habitat from Leipsic to Little Creek totaling about 2200 acres of federal, state and private lands (with 472 acres of this strip being federal refuge lands, amounting to only about 2.9% of the refuge's total area), which at times serves as harborage for massive amounts of refuge-produced adult mosquitoes, it's typically preferable (in conjunction with some timely, judicious larviciding on-refuge) to only infrequently have to aerially adulticide (up to 6 times per year) over this strip than to have to more frequently larvicide over many thousands of acres of nearby refuge marsh. And we of course start here in trying to contend with NWR-produced mosquitoes by undertaking on-refuge as much non-insecticidal, source reduction OMWM work as the USFWS will permit us to do.

Due to many factors that unfortunately are pretty insurmountable, we're not "magicians" in our being able to make but only one mosquito control method fulfill all our mosquito control needs for any given situation – e.g. in the case of our two federal NWRs, we can't perform all of the OMWM work that we'd like to be able to do (in this case because of possible conflicts with other refuge management goals or objectives), nor rely 100% upon larviciding (since we simply wouldn't achieve the full level of mosquito control that's needed), nor rely solely upon adulticiding (which we really wouldn't want to do for environmental reasons, even if this could meet 100% of our mosquito control needs). Rather what's needed to be employed here is a true IPM approach, which we we're forced by real world conditions to take, and that we embrace without apologies to anyone.

The need to keep adulticide use as a very viable and ready control tool was also recently noted even by an agency as conservative in its approach to pesticide regulation as California's State Water Resources Control Board (SWRCB), whereby in a permit-related response dated April 3, 2012 associated with California's new PGP, regarding a request from the San Francisco Baykeeper (a local environmental NGO) to prohibit most all adulticide use in many areas around the state, the SWRCB realistically stated that "Because both larval mosquito control and adult mosquito control are essential vector control programs, the permit should not preclude the appropriate use of both larvicides and adulticides." Indeed, the SWRCB having determined anything less than this relative to adulticide use would have been poor IPM practice, and unnecessarily restrictive of using EPA-registered mosquito control products.

Unnecessary or Unrealistic Limitations on Adulticide Use?

In regard to any restrictions on adulticide use, it's important in part ***not*** to try to limit their use only to situations where a "declared human health emergency" exists, since mosquito control professionals are in the business of *preventing* vector-borne diseases, where the judicious use of adulticides is an important tool for doing such (along with also helping to contend with many other types of mosquito-associated problems). Possibly having to wait to use adulticides until such time as a "declared human health emergency" exists would then be a much less desirable reactive approach for contending with vector-borne diseases, becoming not only poor IPM practice but then also bad public health management too. Not being able to judiciously use such an important control tool as adulticides until "after the horse has left the barn" and human health is now endangered or suffering would be an irresponsible, inexcusable protocol unnecessarily put in place. One must keep in mind that mosquito-caused diseases such as EEE or WNV have a 7-10 day intrinsic incubation period, so when a human case of EEE or WNV first presents at a doctor's office or hospital, it might be indicative of yet more human cases to come during the next week or so that now can't be prevented no matter how much spraying might be quickly undertaken.

Mosquito control adulticides are available to help *prevent* vector-borne diseases, and their use shouldn't be limited only to reacting after the fact to occurrence of vector-borne disease. When you're dealing with problems such as EEE or WNV that are enzootic/endemic throughout Delaware, and which can become epizootic/epidemic if bridge-vectors for these pathogens are not kept in check (Delaware has at least 17 bridge-vector mosquito species), then the most prudent management approach is *to keep bridge-vector populations at acceptably low levels*, which in so doing then not only serves public health purposes, *but concomitantly also addresses quality-of-life problems and socio-economic issues too* (since once again, **good nuisance control = good disease prevention,** and vice versa). Most all modern mosquito control programs around the country manage on the basis of simply keeping mosquito populations at acceptably low levels *for multiple reasons*, especially when dealing with bridge-vector species. And in many cases the best way to achieve this control is via an IPM approach that often involves the use source reduction methods, larvicides and adulticides, such as what we do here in Delaware.

Finally and almost as a sidebar, it should be noted in regard to possibly needing to invoke some type of "declared human health emergency" in order to undertake some types of needed mosquito control treatments, local public health officials (at state, county or municipal levels) are often very reluctant to do this even when seemingly warranted by field conditions, in their then not wanting to set-off any alarm or panic or undue concern with the public, while also avoiding other types of all too common collateral problems associated with such proclamations (e.g. adverse impacts to tourism economies at certain times of the year or in certain locations, cancellations or curtailments of outdoor events, impacts on realty transactions, etc.). Pressure upon public health officials not to issue this type of declaration short of some type of widespread epidemic or plague can come from many sources. It's simply not realistic to think that whenever mosquito control work is needed or warranted for many good reasons that then for some other reason the treatments couldn't be undertaken without also having a "declared human health emergency."

Avoidance of Insecticide Resistance Problems

It is important that we have this diversity of mosquito control insecticide products to call upon, since we need such versatility in dealing with different target species, different brood or life stages, different types of habitats to treat, varying weather conditions to work under, special concerns for avoiding certain types of potential non-target impacts, etc. We must also take steps not to overuse any one of these products against our local mosquito populations, in order to avoid or at least postpone the possible appearance of insecticide resistance (which undercuts effective control) among our target species. Insecticide resistance can arise through overly-aggressively targeting certain species or life stages with but a single pesticide product, such that the small percentage of any species population that might be naturally resistant to whatever insecticide is being used then greatly multiplies because of its essentially insecticide "resistant" or immune nature, to then dominate future generations of the target species (for which we would then have one less control tool that will work). As such, for avoidance of resistance problems alone, it's important to be able to use and rotate a variety of insecticides in our control work, and to also adopt new insecticides whenever possible and appropriate.

Another concern in resistance management is not to under-apply a product in terms of its maximum permissible application rate on the product label. There are often many times, places, situations or circumstances where less than maximum label rates can be appropriately used to still get the job done in terms of control efficacy, while at the same time introducing less pesticides into the environment, which of course is a good thing. But on the other hand, you want to be sure to use a product at high enough spray rates, including up to the maximum label rate if need be, not just for satisfactory control efficacy, but also so that you don't create or promote product resistance within a target species' populations. Too frequently or extensively using a lower spray rate that allows certain segments of the target populations that have some natural or inherent resistance to a product to then selectively survive and propagate more product-resistant offspring, and whereby such offspring then come to dominate target species populations as the product is continued to be used at lower rates, eventually renders future use of the product as worthless. The latter can happen with some surprising speed when less than appropriate spray rates for resistance management are employed on a frequent, widespread basis. The applicator often has to use best professional judgment when deciding for multiple purposes what application rates to actually employ.

Criteria for Determining What Type(s) of Mosquitocide Product(s) to Use

The selection of which type(s) of mosquitocide products to use in the field depends upon many site-specific or condition-specific factors, going beyond just the basic decision as to whether use a larvicide, an adulticide, or perhaps both. For starters, the timing for when we apply our mosquitocides, and for how the applications are done, is determined (and quite often complicated) by weather conditions (e.g. air temperature, wind speed and direction, humidity, rainfall), all which must be considered in our performing appropriate and allowable treatments and the products we choose. When dealing with saltmarsh mosquito larval control, we must also take into consideration daily tide stages and the monthly lunar tide cycle too. In doing our spring woodland-pool species control, we are often racing against the calendar to complete our aerial larviciding campaign before forest canopy leaf-out prevents effective spraying of our products. And one can probably readily envision the many problems we face when trying to treat urban or congested areas – think about all the things you might have to deal with when trying to operate a truck-mounted adulticide sprayer as one encounters crowds of people along the streets, traffic jams, or detours, during an effort to prescriptively apply uniform amounts or concentrations of an insecticide – this is one reason why one might see our inner-city ground adulticiding ("fogging") being performed at 10:00 pm in the evening rather than 5:00 pm in the late afternoon. These kinds of timing factors can influence the types of mosquitocides we choose to use.

In choosing a mosquitocide product to use, applicators have to consider a wide range of questions and factors that in aggregate then determine which product to actually employ. In part such considerations include:

- What type(s) of mosquito species are you attempting to control?
- Are you dealing with larval or adult stages?
- If larval stages, are they primarily early, mid or late stage larvae, or even pupae, or some type of mixture of all these stages?
- In what type(s) of aquatic habitats are the larvae occurring, and what might be some ambient physical or chemical conditions of habitat waters at time of planned treatment?
- What are the weather or tide conditions for spraying (wind direction and speed, air temperature, relative humidity, low or high tide), and what are predicted weather or tide conditions for several days after a spray event occurs?
- How much treatment acreage is involved?
- What type of delivery platform will be used? Fixed-wing aircraft? Helicopters? Sprayers mounted in pick-up truck beds? Backpack sprayers? Hand applications or tosses?
- How nearby are people to where or when you want or need to treat, and in what type of density or numbers?
- What are a treatment area's flora and fauna in an overall sense?
- What might be any special non-target species concerns in the treatment area? In particular, are there any threatened or endangered species concerns?
- What's a product's price to use, in terms of its material cost per acre?

- For aerially applied products, what's a product's price to aerially apply, in terms of its application (flight) cost per acre?
- Are there any concerns with product choice relative to resistance management considerations?
- Once a product is selected, what's the maximum application rate and its maximum application frequency? Do you need or intend to use such maximum spray rates or frequencies, or can you satisfactorily get by using lower rates or frequencies? What are the optimal spray droplet sizes to use during product application? What types and sizes of nozzles will be used, how many nozzles should be placed per boom and set at what angles, and what should the nozzle pressures be? What spray swath widths will you use, and at what altitudes and air speeds will product be applied? Whatever is determined for these types of application considerations has to occur in full conformance with EPA-approved product label requirements and conditions.

1) Larvicides

The Mosquito Control Section's frontline larvicides are *Bacillus thuringiensis* var. *israelensis* products, a.k.a. Bti (e.g. VectoBac, Teknar or Aquabac, which are all bacterially-produced insecticides) and *methoprene* (e.g. Altosid, a juvenile growth hormone mimic), both which can be applied in liquid or granular formulations. *Bti* is primarily effective against earlier immature aquatic stages, and seems to work better (or at least more consistently) for control of freshwater species (e.g. spring woodland-pool breeding species) than for saltmarsh mosquitoes of the open marsh. *Methoprene* is best used against later immature aquatic stages, and is effective against both freshwater and saltmarsh species, but still has to be applied before the larvae pupate. Both *Bti* and *methoprene* are state-of-art, third-generation pesticides that are classified as "biorational" products. Another type of larvicide available to us is *temephos* (e.g. Abate, an organophosphate second-generation insecticide), which we use in liquid formulation for control of freshwater mosquitoes in roadside ditches, or in granular form for saltmarsh mosquito control in areas of dense wetlands vegetation – *temephos* is effective against all larval stages. However, temephos is now in its final years of service before being phased out by EPA and the product manufacturer. A final type of larvicide that we occasionally use are *monomolecular surface films* (e.g. Agnique or Arosurf) to treat larvae or pupae, usually hand-applied to container-breeding or other types of confined freshwater habitats. A newer type of larvicide showing promise that the Section is now using is spinosad (e.g. Natular), which has touted attributes for resistance management and for its benign environmental effects.

As an example of the types of problems and questions encountered when selecting a larvicide product for use, let's look at the choice of Bti or methoprene for saltmarsh mosquito control. For environmental reasons involving relative impacts to non-target organisms, but which still really aren't that well documented or substantiated in a comparative sense, some parties might prefer the use of Bti over methoprene (e.g. the USFWS); but operationally this can't always be the choice, or even the most frequent choice, due to some concomitant control efficacy issues too. For saltmarsh mosquito control based upon our operational experience and field trials too, Bti seems to work best during cooler times of the control season (e.g. spring, early summer), when organic matter in the water column is relatively low, in contrast to warmer times of the season when organic matter in the water column becomes high. Such a difference might be attributable to Bti's mode of action, which requires mosquito larvae to first ingest the Bti spores before the toxic action occurs; when there's a lot of competing organic matter in the water column offering other food choices for the larvae, then probably less Bti spores get ingested. Additionally, in terms of toxic effects after Bti is ingested, efficacy seems to be better for early stage larvae (stage 1 or 2) as opposed to late stage larvae (stage 3 or 4). At times operational use of Bti under these types of situations has led to partial or total treatment failures, where the treatment application then becomes a waste of time, effort and money. To then deal with these types of situations in terms of preventing or avoiding treatment failures, there's often then a preference to use methoprene for its relatively greater control efficacy, especially when dealing with heavily organically-laden waters that often occur in salt marsh potholes during warmer times of the season, or when dealing with a larval brood that might primarily be in its later developmental stages, or that might involve a mix of larval stages from early to late.

What follows is a listing of all larvicide products that the Mosquito Control Section uses or might use for operational control, including a product's brand name and generic category, and its rate of use. Please note that in regard to rates of use below, what are shown below are the rates that we presently typically use for each product, which are of course within the ranges of permissible rates on product labels, but that these rates can change at our discretion due to varying environmental conditions or other special situations at hand. Also please note that when we're working on Delaware's two National Wildlife Refuges, the Section requests to use and the USFWS then typically approves a smaller subset of the listing below, generated by us to meet our lesser range of control needs on-refuge, which is then reflected in the Special Use Permits' (SUPs) Special Conditions that the Service annually issues for larviciding on-refuge.

1) Abate 4E (temephos) applied at 0.048 lbs. AI/A, applied at 1.5 oz. Abate 4E/A mixed with water to achieve a final application volume of 64 oz./A

2) Abate 5BG (temephos) applied at 0.1 lbs. AI/A, applied in granular formulation at 2 lbs./A

3) Abate 2BG (temephos) applied at 0.1 lbs. AI/A, applied in granular formulation at 5 lbs./A

4) VectoBac 12AS (Bti) applied at 32 oz./A

5) VectoBac GS or G (Bti) applied in granular formulation at 10 lbs./A

6) Aquabac XT (Bti) applied at 32 oz./A

7) Aquabac 200G (Bti) applied in granular formulation at 10 lbs./A

8) Teknar SC (Bti) applied at 32 oz./A

9) Teknar G (Bti) applied in granular formulation at 10 lbs./A

10) Altosid Liquid Larvicide (5% methoprene) applied at 0.013 lbs. AI/A, applied at 4 oz./A mixed with water to achieve a final application volume of 32 oz./A

11) Altosid Liquid Concentrate (20% methoprene) applied at 0.013 lbs. AI/A, applied at 1 oz./A mixed with water to achieve a final application volume of 32 oz./A

12) Altosid Pellets (methoprene) applied at 10 lbs./A

13) Altosid SBG (methoprene) applied in granular formulation at 10 lbs./A

14) Altosid Briquets (methoprene) applied at one briquette/100 sq. ft.

15) Altosid XR Extended Residual Briquets (methoprene) applied at one briquette/200 sq. ft.

16) VectoLex CG (Bacillus sphaericus) applied in granular formulation at 20 lbs./A

17) Agnique MMF (nonionic surfactant) applied at 3 oz/1000 sq. ft.

18) Arosurf (nonionic surfactant) applied at 3 oz/1000 sq. ft.

19) Natular EC (spinosad) applied at up to 2.8 oz/A

20) Natular G (spinosad) applied up to 9 lbs./A

2) Adulticides

The Mosquito Control Section's frontline aerially-applied adulticide to treat problem mosquitoes on-wing is *naled* (Trumpet or Dibrom, an organophosphate), which is equally effective against freshwater or saltmarsh mosquitoes. [*Naled* is used by many mosquito control programs around the country, as is another organophosphate adulticide, *malathion* (e.g. Fyfanon, Cythion or Atrapa), which the Section currently does not use.] Another category of adulticides that we use is synthetic pyrethroids, which seem to be more efficacious when applied by truck-mounted sprayers ("foggers") than by aircraft. The primary synthetic pyrethroid that we use for ground adulticiding or "fogging" is *sumithrin* (e.g. Anvil), although alternatives such as *permethrin* (e.g. Permanone, Biomist, Aqua-Reslin) and *resmethrin* (e.g. Scourge) are also available and used around the country, and the Section has used these products too in the past for ground adulticiding. Natural pyrethroid derivatives such as *pyrethrin* (e.g. Pyrenone) can also be used. Unfortunately, in comparison to *naled*, synthetic pyrethroids don't seem to be as efficacious against saltmarsh mosquitoes, nor seemingly as good for aerial applications. Some newer adulticide products that the Section might soon use on trial basis include another type of synthetic pyrethroid, etofenprox (e.g. Zenivex), and a mixture of 2 synthetic pyrethroids, sumithrin + prallethrin, in a product known as Duet. These newer products have some touted attributes either for increased control efficacy or for their benign environmental effects.

Please note that when we use adulticides that are often applied over upland areas or terrestrial habitats, we attempt to accommodate to the extent practicable, and in keeping with our best serving the needs of the general public, those organic gardeners or produce growers who by the conditions of how they want to grow or market their agricultural products try to do this in as pesticide-free manner as possible. And through the Delaware Department of Agriculture (in particular the State Apiarist)**,** along with the Delaware Beekeepers Association, we also have a working agreement and notification protocols with commercial or hobbyist beekeepers, whereby through some mutually proactive measures they can be kept appraised of our pending spray operations, to help avoid any adverse impacts to their beehives or colonies. And in regard to our spraying around or near bees, we of course abide by all product label requirements and conditions, and in accordance with whatever other clarifications EPA might provide.

Some types of adulticides are used as “barrier sprays” to locally treat vegetation in peoples’ backyards, having both repellent and insecticidal effects (involving adulticides such as pyrethrins, permethrin, deltamethrin, bifenthrin, tau-fluvalinate, esfenvalerate, etc.). This type of treatment can provide some limited relief requiring reapplications every 3 weeks or so, and is a customized service provided by some private commercial pest control companies, or qualified homeowners could administer their own barrier sprays. The Mosquito Control Section does not engage in this type of “boutique” homeowner treatment, in its not being a highly efficacious or cost effective approach for the types and scale of problems that we have to deal with. Other types of adulticide methods used in peoples’ backyards include adulticide-dispensing misting machines (e.g. Mosquito Misters) that on a set schedule automatically emit small clouds (“poofs”) of adulticides (typically involving use of pyrethrum, other pyrethrins, permethrin, chlorpyrifos, etc.). Some private commercial pest control companies sell and service these types of devices, or homeowners can do it themselves if they choose. The Mosquito Control Section does not undertake or endorse this type of mosquito control, since its lack of a surveillance-and-monitoring component that might then trigger the need for treatments is lacking, making for poor IPM practice; and also due to both human health and non-target organism impact concerns if/when such devices are improperly used or maintained.

There are also various “natural” products possibly having touted repellent or adulticide effects that EPA recognizes as “Minimum Risk Pesticides” [or FIFRA 25(b) products], but which EPA does not review or regulate, and whose control efficacy typically leaves much to be desired. Such types of “natural” products tend to be various oils of cinnamon, citronella, cedar, mint, garlic, cloves, geranium, peppermint, rosemary, thyme, or white pepper.

What follows is a listing of all adulticide products that the Mosquito Control Section uses or might use for operational control, including a product’s brand name and generic category, and its rate of use (and whereby all adulticide applications are made Ultra Low Volume, or ULV). Please note that in regard to rates of use below, what are shown below are the rates that we presently typically use for each product, which are of course within the ranges of permissible rates on product labels, but that these rates can change at our discretion due to varying environmental conditions or other special situations at hand. Also please note that when we're working on Delaware's two National Wildlife Refuges, the Section requests to use and the USFWS then typically approves a smaller subset of the listing below, generated by us to meet our lesser range of control needs on-refuge, which is then reflected in Special Use Permits' (SUPs) Special Conditions that the Service annually issues for adulticiding on-refuge.

Aerially applied adulticides applied by fixed-wing aircraft or helicopter include:

1) Dibrom Concentrate (naled) applied at 0.10 lbs. AI/A, applied in ULV concentrated formulation of 1.0 oz./A

2) Trumpet EC (naled) applied at 0.10 lbs. AI/A, applied in ULV concentrated formulation of 1.2 oz./A

3) Scourge 18%+54% MF (resmethrin + PBO) applied at 0.007 lbs. resmethrin AI/A + 0.021 lbs. PBO AI/A, mixed with mineral oil, applied at a total volume of 3 oz./A (O.6 oz. Scourge 18-54/A plus 2.4 oz. mineral oil/A)

4) Anvil 10+10 (sumithrin + PBO) applied at 0.0036 lbs. AI/A, applied in ULV concentrated formulation of 0.62 oz./A

5) Permanone 31-66 (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation

6) Biomist 31+66 ULV (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation

7) Kontrol 31-67 Concentrate (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation

8) Evoluer 30-30 ULV (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation

9) Aqualuer 20-20 (permethrin + PBO) applied at 0.0035 lbs. AI/A applied in ULV concentrated formulation.

10) Zenivex E20 (etofenprox) applied at 0.00175-0.0070 lbs. AI/A applied ULV in undiluted, concentrated formulation; or mixed with mineral oil and also applied ULV.

The following adulticides may be ground applied at application rates up to those indicated by truck-mounted Guardian ULV (Ultra Low Volume) or London Fog ULV ground foggers:

1) Scourge 18%+54% MF (resmethrin + PBO) applied at a rate up to 0.007 lbs. resmethrin AI/A + 0.021 lbs. PBO AI/A, mixed with mineral oil, applied at a total volume of 3 oz./A (0.6 oz. Scourge 18-54/A plus 2.4 oz. mineral oil/A)

2) Anvil 10+10 (sumithrin + PBO) applied at 0.0036 lbs. AI/A, mixed with mineral oil, applied at a total volume of 1.24 oz./A (0.62 oz./A Anvil 10+10 plus 0.62 oz. mineral oil/A)

3) Permanone 31-66 (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation

4) Biomist 31+66 ULV (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation

5) Kontrol 31-67 Concentrate (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation

6) Evoluer 30-30 ULV (permethrin + PBO) applied at 0.0035 lbs. AI/A, mixed with mineral oil applied in ULV concentrated formulation

7) Aqualuer 20-20 (permethrin + PBO) applied at 0.0035 lbs. AI/A, applied in ULV concentrated formulation

8) Zenivex E20 (etofenprox) applied at 0.00175-0.0070 lbs. AI/A applied ULV in undiluted, concentrated formulation; or mixed with mineral oil and also applied ULV

9) Duet (prallethrin + sumithrin + PBO) applied at 0.0003-0.0008 lbs. AI/A for prallethrin component, plus 0.0012-0.0036 lbs. AI/A for sumithrin component, both applied as a packaged mix in ULV concentrated formulation

IV. Response Procedures (*also consisting of Attachments I, II, III, IV, V, VI and VII*)

A. Spill Prevention/Response Procedures (including Attachments I, II, III, IV, V)

I. Spill Prevention

1. For Facilities - for Mosquito Control facilities and at contractual aerial applicator’s base of operations.

    i. Perform routine inspections of chemical storage buildings, pumping systems and hazardous waste storage areas. Maintain buildings and pumping system(s) to full function capability.

    ii. Maintain pesticide inventory for each respective facility. These inventories should be adjusted to reflect when pesticides are transferred on or off property. Inventories should be inspected on a routine basis for accuracy.

2. For Pesticide Application Equipment (*including Attachments I, II, III and IV*)

    i. The Delaware Mosquito Control Section’s SOP for “Application Equipment – Schedules and Procedures” will be followed when making chemical applications in accordance with Water Quality Based Effluent Limitations (WQBEL) – *see Attachment I*. Other pertinent parts for this Application Equipment SOP include "Calibration Procedures" – *see Attachment II*; "Pretreatment Inspection of Application Equipment" – *see Attachment III*; and "Application Equipment – Maintenance Schedule" – *see Attachment IV.*

II. Spill Response (*including Attachment V*)

1. If a spill should occur, the applicator will implement procedures described in Delaware Mosquito Control Section's SOP for "Spill Response, Containment, and Notification Procedures" – see *Attachment V.* This SOP includes instructions for immediate response and containment actions for any accidental chemical spill of reportable volumes. The Delaware Mosquito Control will contact the DNREC Emergency Response Team (ERT) at 1-800-662-8802 since they are the lead agency for responding to releases of chemicals to the land, water or air that would threaten human health or the environment. The National Spill Response Center at 1-800-454-8802 should also be contacted to report such spill.

2. All Delaware Mosquito Control applicators will either possess or be accompanied by a staff member who possesses a State of Delaware Certified Applicator License for Mosquito Control (5C). For an applicator to maintain this certification, annual continuing education credits are required.

B. Adverse Incident Response Procedures (*including Attachments VI and VII*)

a. Refer to Delaware Mosquito Control Section's SOP for "Delaware Mosquito Control Adverse Incident Response Procedures" – *see Attachment VI.*

b. Refer to attached "List of Emergency Medical Facilities" – *see Attachment VII.*

c. Hazardous Chemical Responders

1. The DNREC Emergency Response Team (ERT) maintains the list of hazardous chemical responders in the state and utilizes these responders whenever need requires. DNREC's ERT can also be used as a 24-hour resource to provide callers with the names of hazardous chemical responders, in the event they themselves can't or don't investigate a spill/incident.

V. Signature

William H. Meredith

William H. Meredith, Ph.D.
Environmental Program Administrator
Delaware Mosquito Control Section
[senior executive officer]

Date: 4/16/2012

Attachment I – Delaware Mosquito Control
Application Equipment – Schedules and Procedures

Control Measure	Determination of Application Rate	Surveillance Method	Determination of Frequency of application	Spill Prevention/Spill Response Procedures and Schedules	Application equipment calibration procedures	Application equipment maintenance procedures	Environmental Condition Assessment
Larviciding-Ground Applications Liquid and Granular Formulations Delivery System(s): 1.Gas-powered backpack 2.Truck-mounted sprayer 3.Hand Toss/Small Hand Sprayer	Rate efficacy was determined when product was introduced based on comparison of pre-application and post-application larval counts to determine the level of control achieved for a variety of doses.	Larval habitat dips conducted prior to application.	Applications are made when pest threshold levels were exceeded based on surveillance; application frequency is made in accordance with chemical label; DMC "Spray Threshold Criteria" should be followed.	All spray equipment is inspected daily for leaks and maintenance; spill kits are held on all spray vehicles; all employees participate in annual spill prevention training; The DMC SOP titled "Pre-treatment Inspection of Application Equipment" and "Spill Response, Containment, and Notification Procedures" should be followed.	All spray equipment is calibrated at minimum once per year prior to any operational spraying. The DMC SOP for "Calibration Procedures" should be followed.	All spray equipment will be maintained in proper operating condition. Equipment is inspected prior to use for proper maintenance. All equipment is repaired prior to use if deficiencies are discovered. The DMC SOP titled "Application Equipment - Maintenance Schedule" and "Pre-treatment Inspection of Application Equipment" should be followed.	All spray equipment will be maintained in proper operating condition. Equipment is inspected prior to use for proper maintenance. All equipment is repaired prior to use if deficiencies are discovered. The DMC SOP titled "Application Equipment - Maintenance Schedule" and "Pre-treatment Inspection of Application Equipment" should be followed.
Larviciding-Aerial Applications Liquid and Granular Formulations Delivery System(s): 1.Airplane 2.Helicopter	Rate efficacy was determined when product was introduced based on comparison of pre-application and post-application larval counts to determine the level of control achieved for a variety of doses.	Larval habitat dips conducted prior to application.	Applications are made when pest threshold levels were exceeded based on surveillance; application frequency is made in accordance with chemical label; DMC "Spray Threshold Criteria" should be followed.	All spray equipment is inspected daily for leaks and maintenance; spill kits are held on all spray vehicles; all employees participate in annual spill prevention training; The DMC SOP titled "Pre-treatment Inspection of Application Equipment" and "Spill Response, Containment, and Notification Procedures" should be followed.	Aircraft are calibrated annually for proper application rate prior to any operational spraying. All spray equipment is calibrated upon each spray mission by in-flight navigational recording equipment and comparing area sprayed to volume applied yielding an application rate. The DMC SOP for "Calibration Procedures" should be followed.	All spray equipment will be maintained in proper operating condition. Equipment is inspected prior to use for proper maintenance. All equipment is repaired prior to use if deficiencies are discovered. The DMC SOP titled "Application Equipment - Maintenance Schedule" and "Pre-treatment Inspection of Application Equipment" should be followed.	On-site weather conditions are evaluated by trained applicators prior to each spray mission to ensure proper chemical applications in accordance with FIFRA-based chemical labels.
Adulticiding-Ground Applications Liquid ULV Formulations Delivery System: 1.Truck-mounted ULV Fogger	Rate efficacy was determined when product was introduced based on comparison of pre-application and post-application adult mosquito counts to determine the level of control achieved for a variety of doses.	Any combination of landing rate counts, service request, and/or light trap counts are used to assess adult mosquito population size and direct spray missions	Applications are made when pest threshold levels were exceeded based on surveillance; application frequency is made in accordance with chemical label; DMC "Spray Threshold Criteria" should be followed.	All spray equipment is inspected daily for leaks and maintenance; spill kits are held on all spray vehicles; all employees participate in annual spill prevention training; The DMC SOP titled "Pre-treatment Inspection of Application Equipment" and "Spill Response, Containment, and Notification Procedures" should be followed.	Application equipment must be calibrated at minimum once per year prior to any operational spraying. Calibration will confirm the desired pressure at the nozzle and nozzle flow rate(s) are properly achieved. In addition, spray equipment must be calibrated so that the volume median diameter (VMD) produced is in compliance with the label of the selected pesticide. The DMC SOP for "Calibration Procedures" should be followed.	All spray equipment will be maintained in proper operating condition. Equipment is inspected prior to use for proper maintenance. All equipment is repaired prior to use if deficiencies are discovered. The DMC SOP titled "Application Equipment - Maintenance Schedule" and "Pre-treatment Inspection of Application Equipment" should be followed.	On-site weather conditions are evaluated by trained applicators prior to each spray mission to ensure proper chemical applications in accordance with FIFRA-based chemical labels.
Adulticidiing-Aerial Applications Liquid Formulations Delivery System(s): 1.Airplane 2.Helicopter	Rate efficacy was determined when product was introduced based on comparison of pre-application and post-application adult mosquito counts to determine the level of control achieved for a variety of doses.	Any combination of landing rate counts, service request, and/or light trap counts are used to assess adult mosquito population size and direct spray missions	Applications are made when pest threshold levels were exceeded based on surveillance; application frequency is made in accordance with chemical label; DMC "Spray Threshold Criteria" should be followed.	All spray equipment is inspected daily for leaks and maintenance; spill kits are held on all spray vehicles; all employees participate in annual spill prevention training; The DMC SOP titled "Pre-treatment Inspection of Application Equipment" and "Spill Response, Containment, and Notification Procedures" should be followed.	Application equipment must be calibrated at minimum once per year prior to any operational spraying. Calibration will confirm the desired pressure at the nozzle and nozzle flow rate(s) are properly achieved. In addition, spray equipment must be calibrated so that the volume median diameter (VMD) produced is in compliance with the label of the selected pesticide. The DMC SOP for "Calibration Procedures" should be followed.	All spray equipment will be maintained in proper operating condition. Equipment is inspected prior to use for proper maintenance. All equipment is repaired prior to use if deficiencies are discovered. The DMC SOP titled "Application Equipment - Maintenance Schedule" and "Pre-treatment Inspection of Application Equipment" should be followed.	All spray equipment will be maintained in proper operating condition. Equipment is inspected prior to use for proper maintenance. All equipment is repaired prior to use if deficiencies are discovered. The DMC SOP titled "Application Equipment - Maintenance Schedule" and "Pre-treatment Inspection of Application Equipment" should be followed.

Attachment II

Delaware Mosquito Control Section
Standard Operating Procedure
Calibration of Insecticide Spray Equipment

Objective: To establish a set of instructions for the calibration of commonly used spray equipment.

Overview: All spray equipment needs to be calibrated in order to ensure accurate application of chemicals within the confines of EPA/FIFRA established limits. These limits are in place as a safeguard to minimize undesirable environmental impacts while simultaneously ensuring efficacious results in the target species.

All calibrations must start with a rate of application determination as expressed in “acres treated per minute” and is determined with the formula (swath width, in feet) x (travel speed, in mph) x (0.0020202). This rate of application is unique for different modes of application.

Second, the applicator must determine the flow rate of the spray equipment as expressed in oz/min, gallons/min or lbs/min. The flow rate of the equipment must be determined and appropriately modified such that chemical application rates are within EPA prescribed limits and generally expressed as oz. /acre, gal/acre or lbs. /acre. This information is provided on the chemical label.

AIRCRAFT

Larvicides:

1) Calibrating rotary wing aircraft for liquid larvicide applications (on the ground)
   a) Energize electric spray pump system from ground based source.
   b) Load chemical into the chemical tank.
   c) Place a graduated collection/measuring device under each of the chemical spray nozzles.
   d) Run the spray system to purge all air then empty and reset all collection devices.
   e) Run the spray system for a 60 second period and collect spray flow.
   f) Measure and record the volume collected from each nozzle and the combined total for the full run.
   g) Adjust flow rate by increasing or decreasing spray pressure and/or nozzle orifice size.
   h) Re-run additional spray trials until the required spray volume (within ±5% of calculated value) has been achieved.

2) Calibrating fixed wing aircraft for liquid larvicide applications (in flight)
    a) Using water as a surrogate for the chemical being calibration, load a known volume of water (typically 20-30 gallons) into the aircraft's chemical tank.
    b) Have pilot taken off and apply water at typical operational spray conditions and record time required to apply all water in tank.
    c) Upon landing, the spray time is recorded and compared to the time calculated for the specific chemical and rate being calibrated.
    d) Adjust flow rate by increasing or decreasing spray pressure and/or nozzle orifice size.
    e) Re-run additional spray trials until the required spray volume (within ±5% of calculated value) has been achieved.

3) Calibrating rotary and fixed wing aircraft for granular larvicide applications (in flight)
    a) Twenty plastic buckets are place in a straight single line, 5 feet apart, in an open field perpendicular to the direction of the wind (wind should be below the operational speed, typically <10mph).
    b) Load chemical into hopper.
    c) Have aircraft take off and fly over the bucket array into the direction of the wind at the established spray altitude, speed, and hopper throat opening while applying the chemical.
    d) After the aircraft completes the fly over of the collection array, count the number of granules in each bucket and record.
    e) The total count is converted into a weight (conversion factor is established for each product) and divided by the combined cross sectional area for all the bucket openings and compared to the calculated rate (lbs. /acre) for the chemical.
    f) Application rate is adjusted by increasing or decreasing the opening size of the mechanical gate on the chemical hopper.

Adulticides:

1) Calibrating rotary and fixed winged aircraft for adulticide applications (on ground and in flight)
    a) Energize electric spray pump system from ground based source.
    b) Add chemical to be calibrated to the chemical tank.
    c) Load chemical into the chemical tank.
    d) Place a graduated collection/measuring device under each of the chemical spray nozzles.
    e) Run the spray system to purge all air then empty and reset all collection devices.
    f) Run the spray system for a 60 second period and collect spray flow.
    g) Measure and record the volume collected from each nozzle and the combined total for the full run.

h) Adjust flow rate by increasing or decreasing spray pressure and/or nozzle orifice size.
i) Re-run additional spray trials until the required spray volume (within ±5% of calculated volume) has been achieved.
j) To verify the spray system is also delivering the required spray droplet spectrum, place 3 slide spinners, loaded with Teflon coated slides, in a straight single line, roughly 100 feet apart, in an open field perpendicular to the direction of the wind (wind should be below the operational speed, typically <10mph). In the same array place 20 spray sensitive cards on stakes every 100 feet across the line of flight.
k) Have aircraft take off and fly over the spinner and card array into the direction of the wind at the established spray altitude, speed, and spray system settings, as established above, while applying the chemical.
l) After the aircraft completes the fly over of the collection array, collect the slides and cards (placing in sealed containers while keeping track of the position of each in the array) for later analysis in the laboratory.
m) Back in the laboratory, process the Teflon slides using a compound microscope equipped with an optical micrometer in one ocular and mechanical stage. Place a slide on the mechanical stage and systematically measure the diameter of at least 100 spray droplets deposited on the slide as a result of the spray application (use additional slides if necessary to achieve the 100 drop requirement). Enter the resulting data into REMSpC Slide Analysis software (SA) data sheet and record the resulting output.
n) Compare the resulting SA output to confirm that the spray droplet spectrum falls within the specification required for the product being used. In the case of Trumpet EC, the volume median diameter (VMD) should be less than 40 microns (Dv 0.5 < 40 μm) and 90% of the spray cloud is contained in droplets smaller than 75 microns (Dv 0.9 < 75 μm).
o) Also examine the spray cards for number of spray drops present and record for each card. Once all cards have been read, determine the effective spray width of the test spray run and record on the calibration record as required.

GROUND EQUIPMENT

1) Calibrating truck-ULV equipment
    a) Application equipment must be calibrated at least annually to confirm that pressure at the nozzle and nozzle flow rate(s) are properly calibrated. In addition, spray equipment must be calibrated so that the volume median diameter (VMD) produced is in compliance with the label of the selected pesticide.
    b) Follow the calibration instructions for the Adapco Monitor 3 and 4 that are found in the User's Manual. These instructions will calibrate for proper flow rate of the selected pesticide.

    c) Specialized equipment is used to calibrate for the proper VMD of the selected pesticide.

2) Calibrating backpack units (Maruyama, Stihl) for Granular Applications
    a) Load chemical into the chemical tank
    b) Start the engine, run at half throttle
    c) Determine swath width
    d) Place a collection bag over the discharge port
    e) Collect and weigh the granular material, using determined swath widths
    f) Adjust the position of the “throat” control lever to achieve proper calibration settings

3) Calibrating truck “ditch” sprayers
    a) Fill tank with half of the full volume with water and spray the water back into the tank until no air bubbles are present; the pump is now primed
    b) Assume vehicle speed is 10 mph and swath width is 5 feet resulting in 0.10101 acres treated per minute
    c) Measure the volume released for one minute to calculate gallons/acre
    d) As a general rule, the discharge rate is 2 gallons of water per minute resulting in an application rate of 20 gallons/acre at 10 mph and 5 ft swath

<u>Pertinent Emergency Regulations Section Requirements</u>:

9.8.9 Operator’s Responsibilities (all operators)

9.8.9.1 Requirement to use BMP

9.8.9.1.2 Maintain pesticide application equipment in proper operating condition, including requirement to calibrate, clean, and repair such equipment and prevent leaks, spills, or other unintended discharges.

9.8.12 Recordkeeping

9.8.12.1 Recordkeeping for all Operators

9.8.12.1.1 All Operators must keep the following records:

9.8.12.1.1.7 Documentation of equipment calibration.

Attachment III

Delaware Mosquito Control
Standard Operating Procedure
Pre-treatment Inspection of Application Equipment

Airplane – Adulticide and Liquid or Granular Larvicide Applications

1. Verify proper Personal Protective Equipment (PPE), Spill Containment Kit, MSDS and Labels, and Emergency Contact numbers are readily available in the aircraft.
2. Complete a preflight inspection in accordance with the FAA flight manual.
3. Visually inspect all lines, fittings and pump for deterioration and cracks and wear.
4. Clean all tips orifices and screen while wearing the proper PPE.
5. While wearing the proper PPE pressurize system with water and check for signs of leaks.

Helicopter – Adulticide and Larvicide Applications

1. Verify proper Personal Protective Equipment (PPE), Spill Containment Kit, MSDS and Labels, and Emergency Contact numbers are readily available in the aircraft.
2. Complete a preflight inspection in accordance with the FAA flight manual.
3. Visually inspect all lines, fittings and pump for deterioration and cracks and wear.
4. Clean all tips orifices and screen while wearing the proper PPE.
5. While wearing the proper PPE pressurize system with water and check for signs of leaks.

Truck Mounted Fogger – Adulticide Applications

1. Verify proper Personal Protective Equipment (PPE), Spill Containment Kit, MSDS and Labels, and Emergency Contact numbers are readily available on vehicle.
2. Verify engine oil and gas are at appropriate levels
3. Inspect hoses for leaks and/or cracks
4. Check spray tank for any leaks or cracks and that they are secured properly

Truck Mounted Sprayer – Larvicide Applications

1. Verify proper Personal Protective Equipment (PPE), Spill Containment Kit, MSDS and Labels, and Emergency Contact numbers are readily available on vehicle.
2. Verify engine oil and gas are at appropriate levels
3. Inspect hoses for leaks and/or cracks
4. Check spray tanks for any leaks or cracks and that they are secured properly
5. Verify calibration settings before beginning application

Backpack Sprayer – Liquid or Granular Larvicide Applications

1. Verify proper Personal Protective Equipment (PPE), Spill Containment Kit, MSDS and Labels, and Emergency Contact numbers are readily available on vehicle.
2. Verify proper 40:1 oil/gas mixture is used
3. Inspect hoses for leaks and/or cracks
4. Check spray tanks for any leaks or cracks and that they are secured properly
5. Verify calibration settings before beginning application

Small Handheld Applicator – Larvicide Applications

1. Verify proper Personal Protective Equipment (PPE), Spill Containment Kit, MSDS and Labels, and Emergency Contact numbers are readily available on vehicle.
2. Check for any leaks at the spray tip or handle
3. Inspect canister for damage

If any problems with equipment are found, DO NOT use and report them to your supervisor immediately.

Attachment IV

Delaware Mosquito Control Section
Standard Operating Procedures
Application Equipment - Maintenance Schedule

Application Equipment	**Application equipment maintenance schedule and procedures -** All spray equipment will be maintained in proper operating condition. Equipment is inspected prior to use for proper maintenance. All equipment is repaired prior to use if deficiencies are discovered.
1. Airplane	**Annual** - annual inspection, all rubber o-rings are replaced and new poly lines are installed **100 hour** - inspection **Pre-flight (daily)** - lines visually inspected, chemical screen cleaned, and the system is pressurized with water to inspect for leaks. After every use the nozzles and screen are removed and system is flushed until clean.
2. Helicopter	**Annual** - annual inspection, all rubber o-rings are replaced and new poly lines are installed **100 hour** - inspection **Pre-flight (daily)** - lines visually inspected, chemical screen cleaned, and the system is pressurized with water to inspect for leaks. After every use the nozzles and screen are removed and system is flushed until clean.
3. Truck-mounted ULV Fogger	**Annual** - engine checked/oil changed, blower oil changed/greased/belt checked, chemical filter cleaned, lines/fittings/fasteners checked and replaced as needed, winterize
4. Gas-powered backpack	**Annual** - general engine check, tank inspected/cleaned, winterize
5. Truck-mounted sprayer	**Annual** - engine checked/oil changed, chemical filter cleaned, lines checked and replaced as needed, tank inspected, winterize

Attachment V

Delaware Mosquito Control Section
Standard Operating Procedure
Spill Response – Prevention, Containment, and Notification

Scope: This procedure applies to all pesticide applicators and handlers to discuss appropriate spill response measures.

Objective: To prevent spills; to quickly contain, clean up, and dispose of spills for environmental protection and public safety.

Methods: Most spills can be avoided through prevention and forward thinking.

- Prevention: Examine containers for possible leaks, especially before transporting. Notify supervisor if container cannot be sealed and material needs to be transferred.
  Work over containment trays or hard surfaces (i.e. pavement) and away from sewers and storm drains whenever possible to avoid ground and water contamination.

IF A SPILL OCCURS:

- Control the spill source and situation. As a handler and applicator, you should already have donned appropriate personal protective equipment prior to the spill. Clear the area; keep unauthorized people away from the spill. Place leaking containers in a chemical-resistant container. Contact supervisor or acting supervisor/manager for assistance. For large spills beyond your capability, notify appropriate local/state/federal authorities (e.g., DNREC Emergency Response at 800-662-8802 and National Spill Response Center at 800-454-8802).

- Clean up spills immediately; never leave a spill.

- Contain and clean up the spill.
  - Liquids: Dike area with nearby soils or absorbent materials to prevent spread. Keep the spill away from waterways, sewers or storm drains. Cover with absorbent material such as kitty litter. Sweep and shovel absorbent material into containers for disposal. Continue to add absorbent until liquid is removed. Close waste containers tightly and label.
  - Powders, pellets, granules: Sweep/shovel into marked container for re-use or disposal. Cover with absorbent material if becoming airborne.

- Decontaminate the spill site and equipment. See MSDS and/or emergency response personnel for specific information.
    - Non-porous surfaces: Use water and strong detergent to remove residues. Use absorbent materials to collect all rinsate; place into containers for disposal.
    - Porous surfaces such as wood or soil need to be removed.
    - Decontaminate equipment with soap and water; clean up or dispose of PPE. Porous materials are saturated with pesticide (e.g., brooms, leather shoes) should be discarded.

- Disposal: Contact an approved hazardous waste disposal company. This is best done via contacting DNREC Emergency Response first.

- Reporting: Complete a Spill Incident Report (this is automatically done if DNREC Emergency Response responds). Check MSDS for CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) reportable quantity, the Delaware List of Chemicals and Reportable Quantities at (http://regulations.delaware.gov/AdminCode/title7/1000/1200/1203.shtml#TopOfPage) and the EPA via the National Spill Response Center at (800)-454-8802.

- Contacts: For a Reportable Spill (see numbers above for determining if reportable and MSDS label for volumes/amount). Contact DNREC Emergency Response at 800-662-8802, Delaware Dept. of Agriculture's Pesticide Compliance Section at 800-282-8685, the National Spill Response Center at 800-454-8802 and the National Pesticide Telecommunications Network – 800/858-7378. For human exposure concerns, contact the National Poison Control Center at 800-222-1222.

PRODUCT	DE	CERCLA	PPE REQUIREMENTS
Abate 2-BG	5,000 lbs. (100 lbs. Temephos)	None	**Loaders, applicators and other handlers involved in ground applications, loaders and applicators involved in backpack blower applications must wear:** - long-sleeved shirt and long pants - shoes and socks -chemical-resistant gloves - protective eyewear, such as goggles, or safety glasses. **All other loaders, applicators and handlers must wear:** -coveralls over long-sleeved shirt and long pants -chemical-resistant gloves -chemical-resistant footwear plus socks -protective eyewear, such as goggles or safety glasses -chemical-resistant headgear (if overhead exposure). **Loaders supporting aerial applications must wear:** -dust mist filtering respirator with MSHA/NIOSH approval number prefix TC- 21C or a NIOSH-approved respirator with any M, R, P, or HE Filter. **Loaders and cleaners of equipment must wear:** -chemical-resistant apron.
Abate 4E	27,746 gal. (1,000 lbs. Toluene) 24.9 gal. (100 lbs. Temephos)	27,746 gal. (1,000lbs. Toluene)	**Mixers, loaders, and ground applicators must wear:** -long-sleeved shirt and long pants -shoes and socks -chemical resistant gloves. **Aerial applicators must wear:** -long-sleeved shirt and long pants -shoes and socks. **Flaggers must wear:**

			-long-sleeved shirt and long pants -shoes and socks - protective eyewear.
Agnique MMF	None	None	**Hand protection:** Protective gloves made of rubber. **Eye protection:** Safety glasses with side shields.
Agnique MMF G	None	None	**Respiratory protection:** Nuisance dust mask if use causes dusting. **Hand protection:** Appropriate chemical resistant gloves. **Eye protection:** Safety glasses with side shields. **Skin protection:** Wear suitable protective clothing
Altosid Briquette (150day)	None	None	Avoid contact with skin, eyes and clothing. Wash thoroughly with soap and water after handling. Use good Industrial Hygiene practices including protective gloves and eyewear. If prolonged exposure to high levels of dust is expected, approved respiratory protection may be required.
Altosid Briquette (30day)	None	None	Under ordinary use conditions, no special protection is required. If prolonged exposure is expected, it is recommended to wear a MSHA/NIOSH approved organic vapor/pesticide respirator, impervious gloves, chemical goggles or safety glasses with side shields.
Altosid Liquid Larvicide (20%)	None	None	Under ordinary use conditions, no special protection is required. If prolonged exposure is expected, it is recommended to wear a MSHA/NIOSH approved organic vapor/pesticide respirator, impervious gloves, chemical goggles or safety glasses with side shields.
Altosid Liquid Larvicide (5%)	None	None	Under ordinary use conditions, no special protection is required. If prolonged exposure is expected, it is recommended to wear a MSHA/NIOSH approved organic vapor/pesticide respirator, impervious gloves, chemical goggles or safety glasses with side shields.
Altosid Pellets	None	None	Under ordinary use conditions, no special protection is required. If prolonged exposure is expected, it is recommended to wear a MSHA/NIOSH approved organic vapor/pesticide respirator, impervious gloves, chemical goggles or safety glasses with side shields.
Altosid SBG	None	None	Due to the size and abrasiveness of the granule, use protective eyewear and clothing to minimize exposure during loading and handling.
Altosid XRG	None	None	Due to the size and abrasiveness of the granule, use protective eyewear and clothing to minimize exposure during loading and handling.
Anvil 10+10	135.1 gal (100 lbs. Phenothrin) 135.1 gal (100 lbs. PBO)	None	Personal protective equipment should be selected based upon the conditions under which this material is used. **Eyes and Face:** Take prudent precautions to avoid contact with eyes. **Skin:** Take prudent precautions to avoid contact with skin and clothing.
Aqua Anvil	117.7 gal (100 lbs. Phenothrin) 117.7 gal (100 lbs. PBO)	None	**Eye Protection:** Handlers and Applicators should take prudent precautions to avoid contact with eyes. **Skin Protection:** Handlers and Applicators should wear long-sleeved shirt and long pants, socks and shoes. **Respiratory Protection:** A respirator is not normally required when handling this product. Use in well ventilated areas.
Aqua Duet	4.9 gal (1 lb. Pyrethrin) 243.7 gal (100 lbs. PBO)	4.9 gal. (1 lb. Pyrethrin)	**Eye Protection:** OSHA-approved safety glasses, goggles or face shield suggested when mixing or loading tank. **Skin Protection:** Handlers should wear protective clothing and chemical resistant gloves when mixing or loading tank **Respiratory Protection:** Not likely to be needed
Aqua Halt	2.4 gal. (1lb. Pyrethrin) 47.5 gal (100 lbs. PBO)	2.4 gal. (1 lb. Pyrethrin)	**Eyes and Face:** Take prudent precautions to avoid contact with eyes. **Skin:** Take prudent precautions to avoid contact with skin and clothing. **Respiratory:** Wearing a respirator is not normally required when handling this product. Use in well ventilated areas. Take prudent precautions to avoid breathing vapors and/or spray mists of this product.
Aquabac 200 G	None	None	Mixers/loaders and applicators not in enclosed cabs or aircraft must wear a dust/mist filtering respirator meeting NIOSH standards of at least N-95, R-95, or P-95.
Aquabac XT	None	None	**Applicators and other handlers must wear:** -long-sleeved shirt and long pants -waterproof gloves -shoes plus socks. **Mixers/loaders and applicators not in enclosed cabs or aircraft must wear:** -dust/mist filtering respirator meeting NIOSH standards of at least N-95, R-95, or P-95.
Arosurf MSF	None	None	**Protective Gloves**: impervious gloves. **Eye Protection:** chemical workers goggles.
Biomist 31+66	0.35 gal. (1 lb. Pyrethrin) 16.7 gal (100 lbs. PBO)	None	**Mixers, loaders, applicators, and other handlers must wear**: -long-sleeve shirt and long pants -shoes plus socks. **In addition, all handlers except for applicators using motorized ground equipment, pilots and flaggers, must wear:** --chemical-resistant gloves. **In addition, mixers/loaders, persons cleaning equipment, and other persons exposed to the concentrate must wear**: -chemical-resistant apron.

Dibrom Concentrate	0.7 gal. (10lbs. Naled) 33.1 gal. (10 lbs. Dichlorovos) 6,61l.2 gal. (100 lbs. Napthalene)	0.7 gal. (10lbs. Naled)	**Mixers, loaders, and other handlers must wear:** -Protective eye wear (goggles, face shield, or safety glasses) -Long-sleeved shirt and long pants -Socks plus shoes -Chemical-resistant gloves (barrier laminate, butyl rubber, nitrile rubber, or viton, selection category E) -apron when mixing or loading **In addition, mixers and loaders must:** -Have immediately available for use in an emergency, such as a broken package, spill, or equipment breakdown the PPE specified above for handlers engaged in those activities for which use of an engineering control is not possible **Mixers, loaders, applicators and other handlers engaged in those handler activities for which use of an engineering control is not possible, such as cleaning up a spill or leak and cleaning or repairing contaminated equipment, must wear:** -Protective eye wear (goggles, face shield, or safety glasses) -Coveralls over long-sleeve shirt and long pants -Chemical-resistant gloves -Chemical-resistant footwear plus socks -Chemical-resistant apron if exposed to the concentrate -Chemical-resistant headgear for overhead exposure -A respirator with an organic-vapor removing cartridge with a pre-filter approved for pesticides (MSHA/NIOSH approval number prefix TC-23G), or a canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G), or a NIOSH- approved respirator with an organic vapor (OV) cartridge or canister with any R, P, or HE pre-filter. Please note that N designation for respirator filters does not apply when application is made with oils.
Duet	279.2 gal. (100 lb. Sumithrin) 279.2 gal (100 lbs. PBO)	None	**Eye and Face Protection:** Take prudent precautions to avoid contact with eyes. **Skin Protection:** Take prudent precautions to avoid contact with skin and clothing. **Respiratory Protection:** Wearing a respirator is not normally required when handling this product. Use in well ventilated areas.
Kontrol 31-67	34.9 gal. (100 lb. Permethrin) 16.1 gal (100 lbs. PBO)	None	**RESPIRATORY PROTECTION:** Atmospheric levels should be maintained below the exposure guideline. For most conditions, no respiratory protection should be needed; however, if the exposure guideline is exceeded, use an air-purifying respirator approved for pesticides (U.S. NIOSH/MSHA, EU CEN, or comparable certification organization). **EYE/FACE PROTECTION:** Use chemical protective goggles or a face shield. **SKIN PROTECTION:** Wear coveralls or long-sleeved shirt and long pants, chemical protective gloves (nitrile, neoprene, or Viton® brand), head covering and shoes plus socks. For increased exposures, wear a full body cover barrier suit, such as a PVC rain suit. Contaminated leather articles, such as shoes, belts, and watchbands, should be removed and destroyed. Launder all work clothing before reuse. Keep work clothing separated from household laundry.
Mineral Oil-Sunpar 107	None	None	**EYE PROTECTION:** Splash proof chemical goggles are recommended to protect against the splash of product. **GLOVES or HAND PROTECTION:** Protective gloves are recommended when prolonged skin contact cannot be avoided. The glove(s) listed below may provide protection against permeation. Gloves of other chemically resistant materials may not provide adequate protection. Polyvinyl chloride (PVC); Neoprene; Nitrile; Polyvinyl alcohol; Viton; **RESPIRATORY PROTECTION:** Concentration in air determines the level of respiratory protection needed. Use only NIOSH certified respiratory equipment. Respiratory protection is not usually needed unless product is heated or misted. Half-mask air purifying respirator with dust / mist filters or HEPA filter cartridges is acceptable for exposures to ten (10) times the exposure limit. Full-face air purifying respirator with dust / mist filters or HEPA filter cartridges is acceptable for exposures to fifty (50) times the exposure limit. Protection by air purifying respirators is limited. Use a positive pressure-demand full-face supplied air respirator or SCBA for exposures greater than fifty (50) times the exposure limit. If exposure is above the IDLH (Immediately Dangerous to Life and Health) or there is the possibility of an uncontrolled release, or exposure levels are unknown, then use a positive pressure-demand full-face supplied air respirator with escape bottle or SCBA. Wear a NIOSH-approved (or equivalent) full

			face piece airline respirator in the positive pressure mode with emergency escape provisions. **OTHER:** Where splashing is possible, full chemically resistant protective clothing (e.g., acid suit) and boots are required. The following materials are acceptable for use as protective clothing: Polyvinyl alcohol (PVA); Polyvinyl chloride (PVC); Neoprene; Nitrile; Viton; Polyurethane; Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Remove contaminated clothing and wash before reuse. For non-fire emergencies, respiratory protection may be necessary and wear appropriate protective clothing to avoid contact with material.
Natular 2EC	None	None	Wear protective eyewear.
Natular G	None	None	Wear protective eyewear (such as goggles, face shield, or safety glasses).
Natular G30	None	None	Wear protective eyewear (such as goggles, face shield, or safety glasses).
Natular T30	None	None	**SKIN PROTECTION**: No precautions other than clean body covering clothing should be needed
Natular XRT	None	None	**SKIN PROTECTION:** No precautions other than clean body covering clothing should be needed **APPLICATORS AND ALL OTHER HANDLERS:** Wear protective eyewear to avoid eye contact with dust.
Permanone 31-66	34.9 gal. (100 lb. Permethrin) 16.05 gal (100 lbs. PBO)	None	**Eye/Face Protection:** Safety glasses with side-shields **Hand protection:** Chemical resistant nitrile rubber gloves **Body Protection:** Wear long-sleeved shirt and long pants and shoes plus socks. **Respiratory protection:** When respirators are required, select NIOSH approved equipment based on actual or potential airborne concentrations and in accordance with the appropriate regulatory standards and/or industry recommendations.
Pro Flush	7,069 gal. (5,000 lbs. Methanol) 388.4 gal. (1,000 lbs. Ethanol)	7,069 gal. (5,000 lbs. Methanol)	**Respiratory Protection:** NIOSH/MSHA APPROVED ORGANIC VAPOR RESPIRATOR OR AIR SUPPLIED MASK. **Ventilation:** ADEQUATE VENTILATION TO MAINTAIN VAPOR TLV BELOW 200 PPM. MECHANINCAL AND EXPLOSION PROOF EXHAUST. **Protective Gloves:** NEOPRENE OR RUBBER GLOVES. **Eye Protection:** CHEM WORK GOG/FULL LENGTH FSHLD. **Other Protective Equipment:** SAFETY SHOWER, EYE WASH, RUBBER SAFETY SHOES, HARD HAT. FOR MAJOR EXPOSURE A COMPLETE RUBBER SUIT WITH BOOTS.
ProVect 4E	24.0 gal. (100 lbs. Temephos)	None	**Loaders, and applicators involved in backpack blower application to sites other than tire piles must wear:** -Long-sleeved shirt and long pants, -Shoes and socks, -Chemical resistant gloves **Aerial applicators and flaggers must wear:** -Long-sleeved shirt and long pants, -Shoes and socks, -Chemical resistant headgear (flaggers only) **All other mixers, loaders, applicators and other handlers must wear:** -Cloth coveralls over long-sleeved shirt and long pants, -Chemical-resistant gloves, -Chemical-resistant footwear plus socks, -Chemical-resistant headgear (if overhead exposure) **In addition loaders and cleaners of equipment must wear:** -Chemical resistant apron. **In addition loaders supporting aerial applications and loader/applicators using a backpack power blower on tire pile sites must wear:** **-**A NIOSH-approved dust mist filtering respirator with NSHA/NIOSH approval number prefix TC-21C or a NIOSH-approved respirator with any N, R, P, or HE filter.
Pyrocide 5+25	2.1 gal. (1 lb. Pyrethrin) 210.6 gal (100 lbs. PBO)	2.7 gal. (1 lb. Pyrethrin)	**EYES AND FACE:** Take prudent precautions to avoid contact with eyes. **SKIN:** Take prudent precautions to avoid contact with skin and clothing. **RESPIRATORY:** Wearing a respirator is not normally required when handling this product. Use in well ventilated areas. Take prudent precautions to avoid breathing vapors and/ or spray mists of this product.
Riptide Pyrethrin ULV	2.4 gal. (1 lb. Pyrethrin) 237.3 gal (100 lbs. PBO)	2.4 gal. (1 lb. Pyrethrin)	**EYES AND FACE:** Take prudent precautions to avoid contact with eyes. **SKIN:** Take prudent precautions to avoid contact with skin and clothing. **RESPIRATORY:** Wearing a respirator is not normally required when handling this product. Use in well ventilated areas. Take prudent precautions to avoid breathing vapors and/ or spray mists of this product.

Scourge 18+54	22.0 gal (100 lbs. PBO) 48.2 gal. (100 lbs. Naphthalene) 66.1 gal (100 lbs. Resmthrin)	48.2 gal. (100 lbs. Naphthalene)	**Eye/Face Protection:** Safety glasses with side-shields **Hand protection:** Wear suitable gloves **Body Protection:** Wear long-sleeved shirt and long pants and shoes plus socks. **Respiratory protection:** When respirators are required, select NIOSH approved equipment based on actual or potential airborne concentrations and in accordance with the appropriate regulatory standards and/or industry recommendations.
Spheratax SPH (50) G	None	None	**Mixers, loaders, and applicators not in enclosed cabs or aircraft must wear:** **-**dust I mist filtering respirator meeting NIOSH standards of at least N-95, R-95, or P-95.
Teknar SC	None	None	**RESPIRATORY PROTECTION:** Not usually required. If necessary (Mixers/loaders and applicators not in enclosed cabs or aircraft), use a MSHA/NIOSH approved (or equivalent) respirator with a dust/mist filter (N-95, R-95, or P95). **SKIN PROTECTION:** Impervious, waterproof gloves and clothing to minimize skin contact. **EYE PROTECTION:** Not usually required. If necessary, use safety glasses or goggles. **OTHER PROTECTION:** Wash thoroughly with soap and water after handling.
Trumpet EC	1.2 gal (10 lbs. Naled) 239.8 gal. (100 lbs. Napthalene)	1.2 gal (10 lbs. Naled)	**Mixers, loaders, and other handlers must wear:** -Protective eye wear (goggles, face shield, or safety glasses) -Long-sleeved shirt and long pants -Socks plus shoes -Chemical-resistant gloves (barrier laminate, butyl rubber, nitrile rubber, or viton, selection category E) and apron when mixing or loading **In addition, mixers and loaders must:** -Have immediately available for use in an emergency, such as a broken package, spill, or equipment breakdown the PPE specified above for handlers engaged in those activities for which use of an engineering control is not possible **Mixers, loaders, applicators and other handlers engaged in those handler activities for which use of an engineering control is not possible, such as cleaning up a spill or leak and cleaning or repairing contaminated equipment, must wear:** -Protective eye wear (goggles, face shield, or safety glasses) -Coveralls over long-sleeve shirt and long pants -Chemical-resistant gloves -Chemical-resistant footwear plus socks -Chemical-resistant apron if exposed to the concentrate -Chemical-resistant headgear for overhead exposure -A respirator with an organic-vapor removing cartridge with a pre-filter approved for pesticides (MSHA/NIOSH approval number prefix TC-23G), or a canister approved for pesticides (MSHA/NIOSH approval number prefix TC-14G), or aNIOSH-approved respirator with an organic vapor (OV) cartridge or canister with any R, P, or HE pre-filter. Please note that N designation for respirator filters does not apply when application is made with oils.
VectoBac 12 AS	None	None	**RESPIRATORY PROTECTION:** Not usually required. If necessary (Mixers/loaders and applicators not in enclosed cabs or aircraft), use a MSHA/NIOSH approved (or equivalent) respirator with a dust/mist filter (N-95, R-95, or P95). **SKIN PROTECTION:** Impervious, waterproof gloves and clothing to minimize skin contact. **EYE PROTECTION:** Not usually required. If necessary, use safety glasses or goggles. **OTHER PROTECTION:** Wash thoroughly with soap and water after handling.
VectoBac GS	None	None	**RESPIRATORY PROTECTION:** Not usually required. However, mixers/loaders and applicators not in enclosed cabs or aircraft must wear a dust/mist respirator meeting NIOSH standards of at least N-95, R-95 or P-95. **SKIN PROTECTION:** Impervious gloves, clothing to minimize skin contact. **EYE PROTECTION:** Not usually required. If necessary, use safety glasses or goggles. **OTHER PROTECTION:** Wash thoroughly with soap and water after handling.
VectoLex/Max CG	None	None	**RESPIRATORY PROTECTION:** Not usually required. However, mixers/loaders and applicators not in enclosed cabs or aircraft must wear a dust/mist respirator meeting NIOSH standards of at least N-95, R-95 or P-95. **SKIN PROTECTION:** Impervious gloves, clothing to minimize skin

			contact. **EYE PROTECTION:** Not usually required. If necessary, use safety glasses or goggles. **OTHER PROTECTION:** Wash thoroughly with soap and water after handling.
VectoBac/Lex /Max WDG	None	None	**RESPIRATORY PROTECTION**: Not usually required. If necessary, use a MSHA/NIOSH approved (or equivalent) respirator with a dust/mist filter. Mixer/loaders and applicators not in enclosed cabs or aircraft must wear a dust/mist filtering respirator meeting NIOSH standards of at least N-95, R-95, or P-95. **SKIN PROTECTION:** Impervious gloves, clothing to minimize skin contact. **EYE PROTECTION:** Not usually required. If necessary, use safety glasses or goggles. **OTHER PROTECTION:** Wash thoroughly with soap and water after handling.
Zenivex E4	None	None	Use appropriate precautions to avoid contact with skin, eyes or clothing. Use splash goggles or safety glasses. Chemical resistant gloves are recommended. If ventilation is inadequate, or airborne concentrations exceed recommended exposure limits, respiratory protection suitable for use with oil mists may be required.
Zenivex E20	None	None	Use appropriate precautions to avoid contact with skin, eyes or clothing. Use splash goggles or safety glasses. Chemical resistant gloves are recommended. If ventilation is inadequate, or airborne concentrations exceed recommended exposure limits, respiratory protection suitable for use with oil mists may be required.

Attachment VI

Delaware Mosquito Control Section
Standard Operational Procedure
Adverse Incident Responses

In the event a DMCS operator discovers, or is made aware of an adverse incident defined as:

> *an unusual or unexpected incident that an Operator has observed upon inspection or of which the Operator otherwise become aware, in which:*

(1) There is evidence that a person or non-target organism has likely been exposed to a pesticide residue, and

(2) The person or non-target organism suffered a toxic or adverse effect.

The phrase toxic or adverse effects includes effects that occur within Waters of the United States on non-target plants, fish or wildlife that are unusual or unexpected (e.g., effects are to organisms not otherwise described on the pesticide product label or otherwise not expected to be present) as a result of exposure to a pesticide residue. These may include:

- *Distressed or dead juvenile and small fishes*
- *Washed up or floating fish*
- *Fish swimming abnormally or erratically*
- *Fish lying lethargically at water surface or in shallow water*
- *Fish that are listless or nonresponsive to disturbance*
- *Stunting, wilting, or desiccation of non-target submerged or emergent aquatic plants*
- *Other dead or visibly distressed non-target aquatic organisms (amphibians, turtles, invertebrates, etc.)*

The phrase, toxic or adverse effects, also includes any adverse effects to humans (e.g., skin rashes) or domesticated animals that occur either from direct contact with or as a secondary effect from a discharge (e.g., sickness from consumption of plants or animals containing pesticides) to Waters of the United States that are temporally and spatially related to exposure to a pesticide residue (e.g., vomiting, lethargy).

In event of an adverse incident that might have resulted from a discharge from a pesticide application, the Operator must immediately notify the Delaware Dept. of Agriculture's Pesticide Compliance Section at 800-282-8685 and appropriate EPA Incident Reporting Contact, as identified at www.epa.gov/npdes/pesticides. This notification must be made by telephone within 24 hours of the Operator becoming aware of the adverse incident and must include at least the following information:

a. The caller's name and telephone number;

b. Operator name and mailing address;
c. If covered under an NOI, the NOI NPDES permit tracking number assigned by EPA;
d. The name and telephone number of a contact person, if different than the person providing the 24-hour notice;
e. How and when the Operator became aware of the adverse incident;
f. Description of the location of the adverse incident;
g. Description of the adverse incident identified and the pesticide product, including EPA pesticide registration number, for each product applied in the area of the adverse incident;
h. Description of any steps the Operator has taken or will take to correct, repair, remedy, clean up, or otherwise address any adverse effects; and
i. If known, the identity of any other Operators authorized for coverage under this permit for discharges from the pesticide application activities that resulted in the adverse incident.

If an Operator is unable to notify EPA within 24 hours, the Operator must do so as soon as possible and also provide an appropriate rationale for why the Operator was unable to provide such notification within 24 hours.

Additionally, within 30 days of a reportable adverse incident, the operator must complete the Thirty (30) Day Adverse Incident Written Report for the Pesticide General Permit (PGP) for Discharges from the Application of Pesticides. A template for completing this is available at **http://www.epa.gov/npdes/pubs/final_pgp.pdf.**

Operators must provide this report to the EPA Region III office at:

United States EPA Region 3
Water Protection Division (3WP40)
1650 Arch Street Philadelphia, PA 19103

and to the Delaware Dept. of Agriculture Pesticide Compliance Section at:

Delaware Department of Agriculture
Pesticide Compliance Section
2320 South DuPont Highway
Dover, Delaware 19901

If not using EPA template, the adverse incident written report must include at least the following information:

a. All information required from the 24 hour adverse incident report above;
b. Date and time the Operator contacted EPA notifying the Agency of the adverse incident, who the Operator spoke with at EPA, and any instructions received from EPA;
c. Location of incident, including the names of any waters affected and appearance of those waters (sheen, color, clarity, etc.);

d. A description of the circumstances of the adverse incident including species affected, estimated number of individual and approximate size of dead or distressed organisms;
e. Magnitude and scope of the affected area (e.g., aquatic square area or total stream distance affected);
f. Pesticide application rate; intended use site (e.g., on the bank, above waters, or directly to water); method of application; and the name of pesticide product and EPA registration number;
g. Description of the habitat and the circumstances under which the adverse incident occurred (including any available ambient water data for pesticides applied);
h. If laboratory tests were performed, an indication of which test(s) were performed, and when; additionally, a summary of the test results must be provided within 5 days after they become available if not available at the time of submission of the 30-day report;
i. Description of actions to be taken to prevent recurrence of adverse incidents; and
j. Signature, date, and certification in accordance with Appendix B, Subsection B.11 of the EPA's 2011 Pesticides General Permit.

NOTE: *If the 24 hour oral report for an adverse incident was made per SOP, and the incident has been corrected, and the incident did not adversely impact health or the environment, then no written report will be made*.

The adverse incident notification and reporting requirements are in addition to what the registrant is required to submit under FIFRA section 6(a)(2) and its implementing regulations at 40 CFR Part 159.

Attachment VII

Locations of Medical Services in Delaware (north to south)

Wilmington Hospital 501 W. 14th Street, Wilmington, DE 19801 302-733-1000; 428-2203

St. Francis Hospital 701 N. Clayton Street, Wilmington, DE 19805 302-421-4100; 421-4333

HealthCare Center at Christiana 200 Hygeia Drive, Newark, DE 19713 302-623-0444; 623-0100 Monday - Saturday: 8am to 8pm; Sundays: 9am to 5pm

Christiana Hospital 4755 Ogletown-Stanton Road, Newark, DE 19718 302-733-1000

Newark Emergency Center 324 E. Main Street, Newark, DE 19711 302-738-4300

Glasgow Medical Aid Unit 2600 Glasgow Avenue, Newark, DE 19702 302-836-8350 Monday - Saturday: 8am to 8pm; Sundays: 9am to 5pm

Middletown Care Center 124 Sleepy Hollow Drive, Middletown, DE 19709 302-449-3100 Monday - Saturday: 8am to 8pm; Sundays: 9am to 5pm

Smyrna Health & Wellness Center 100 S. Main Street, Smyrna, DE 19977 302-659-4444 Monday - Friday: 8am to 6:30pm; Saturday & Sunday: 8am to 4pm

Smyrna-Clayton Medical Services 315-401 North Carter Road, Smyrna, DE 19977 302-653-2010 Monday - Friday: 7:30am to 4:30pm

Kent General Hospital 640 South State Street, Dover, DE 19901 302-674-4700

Bayhealth Walk-In Medical Care 301 Jefferson Avenue, Milford, DE 19963 302-430-5705 Monday - Friday: 12:00pm to 7:00pm

Milford Memorial Hospital 21 West Clarke Avenue, Milford, DE 19963 302-422-3311

Beebe Medical Center 424 Savannah Road, Lewes, DE 19958 302-645-3289; 645-3300

Kmart Walk-in Healthcare Center 19563 Coastal Highway, Rehoboth Beach, DE 19971 302-227-6231 Monday - Saturday: 9am to 7pm; Sunday: 9am to 5pm

Nanticoke Memorial Hospital 801 Middleford Road, Seaford, DE 19973 302-629-6611, Ext. 2401

Millville Emergency Center 205 Atlantic Avenue, Millville, DE 19970 302-539-8450 (Memorial Day through Labor Day)

SUBCONTRACTOR CERTIFICATION
PESTICIDE DISCHARGE MANAGEMENT PLAN

Project Name: Annual mosquito control aerial spray operations in Delaware, performed at request of and under contract to the State of Delaware.

Decision-maker(s): Delaware Mosquito Control Section (DNREC)

As a subcontractor, you are required to comply with the Pesticide Discharge Management Plan (PDMP) for any work that you perform for the above designated project. Any person or group who violates any condition of the PDMP may be subject to substantial penalties or loss of contract. You are encouraged to advise each of your employees working on this project of the requirements of the PDMP. A copy of the PDMP is available for your review.

Each subcontractor engaged in pesticide activities in the pest management area that could impact Waters of the United States must be identified and sign the following certification statement:

I certify under the penalty of law that I have read and understand the terms and conditions of the PDMP for the above designated project.

This certification is hereby signed in reference to the above named project:

Company: Allen Chorman & Son, Inc. or Chorman Spraying, LLC _

Address: 30475 E. Mill Run, Milton, DE. 19968

Telephone Number: 302-684-2770

Type of pesticide application service to be provided: Aerial applications of mosquito control larvicides or adulticides by fixed-wing aircraft or helicopter

Signature: Allen Chorman, Pres.

Title: President

Date: 7/5/12

SUBCONTRACTOR CERTIFICATION
PESTICIDE DISCHARGE MANAGEMENT PLAN

Project Name: Annual mosquito control aerial spray operations in Delaware, performed at request of and under contract to the State of Delaware.

Decision-maker(s): Delaware Mosquito Control Section (DNREC)

As a subcontractor, you are required to comply with the Pesticide Discharge Management Plan (PDMP) for any work that you perform for the above designated project. Any person or group who violates any condition of the PDMP may be subject to substantial penalties or loss of contract. You are encouraged to advise each of your employees working on this project of the requirements of the PDMP. A copy of the PDMP is available for your review.

Each subcontractor engaged in pesticide activities in the pest management area that could impact Waters of the United States must be identified and sign the following certification statement:

I certify under the penalty of law that I have read and understand the terms and conditions of the PDMP for the above designated project.

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Company: Allen Chorman & Son, Inc. or Chorman Spraying, LLC

Address: 30475 E. Mill Run, Milton, DE. 19968

Telephone Number: 302-684-2770

Type of pesticide application service to be provided: Aerial applications of mosquito control larvicides or adulticides by fixed-wing aircraft or helicopter

Signature: Jeffrey A. Chorman

Title: Managing Member

Date: 7/5/12